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## TOADSTOOLS AND THEIR KINDRED.

By Miss E. A. YOUMANS.

IN taking "toadstools" as the text of a little botanical discourse, we start with a familiar notion if not a scientific one; but all science begins with common ideas which it corrects, extends, and develops. Everybody knows what toadstools are, odd-looking things that grow up in the fields and are often kicked aside in rural rambles, of no use to man or beast, and "pizen" to eat. This is the oldest, the widest, and the lowest state of mind upon the subject. But many have got beyond this, and recognize that some of these queer-looking things are actually eatable; these they distinguish as mushrooms, and all the rest are lumped together as toadstools. A step forward, and we become slightly scientific; that is, the different kinds begin to be noted, and compared, and classed with reference to their particular characters. When so much is gained, it soon appears that the subject is much wider than was supposed, and that all these growths are but parts of an extensive division of peculiar plants called *fungi;* and, having reached this state of intelligence, toadstools have disappeared. While, then, the popular term may answer to indicate generally what we are talking about, it conveys no exact meaning. The group of plants represented upon the plate is not merely a family of toadstools, but a collection of fungi. By their unlike characters they belong to separate groups in this class, and each has its separate name;[1] for nomen-

[1] Names of Species shown in the Plate: 1. Fly-blown mushroom—*Agaricus muscarius.* 2. Common mushroom—*Agaricus campestris.* 3. Round-headed morel—*Morchella esculenta.* 4. Small-headed morel—*Morchella hybrida.* 5. Tall cylindrical agaric—*Agaricus comatus.* 6. Variable wood agaric—*Agaricus silvus.* 7. Shaggy agaric—*Agaricus floccosus.* 8. Spangled watery agaric—*Agaricus micaceous.* 9. Warty false puff-ball—*Scleroderma verrucosum.* 10. Large bladder-like peziza—*Peziza vasculosa.* 11. Alpine amanita—*Amanita nivalis.* 12. Red-stemmed boletus—*Boletus luridus.* 13. Scaly hydruim—*Hydruim imbricatum.* 14. Hairy earth-tongue—*Geofelossum hirsutum.* 15. Hispid polyporus—*Polyporus hispidus.* 16. Sulphur-colored polyporus—*Polyporus sulphureus.* 17. Carmine peziza—*Peziza coccinea.* 18. Scaly hydruim—*Hydruim imbricatum.* 19. Pale-

clature must keep pace with science, and its higher discriminations require separate technical terms to mark them. Some people cry out against a few strange words in botany, and make it an excuse for neglecting the study; but the real reason is, a lack of interest in the knowledge of Nature, for they are generally ready enough to spend whole years in the acquisition of strange words by the thousand in foreign languages, living and dead. Scientific terms have an educational value, because they involve and give precision to new ideas, while in acquiring an additional language we are only obtaining new terms for old ideas.

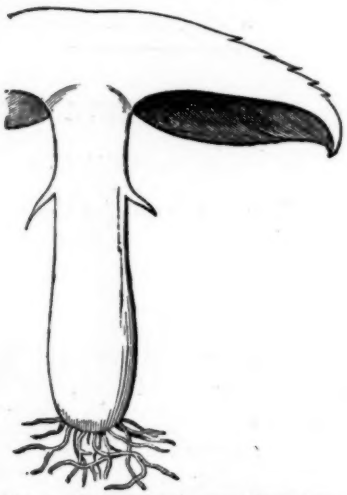

FIG. 1.—SECTION OF COMMON MUSHROOM.

Of all the common objects of the country, toadstools seem to be least related to surrounding things. Neither in form, nor color, nor apparent origin, nor distinguishable parts, do they resemble other plants; and scientific scrutiny must replace common observation before the first step in their classification can be taken. At the very outset of study the botanist is struck by their paradoxical character. In rapidity of growth and speedy decay they are more allied to low animal than to vegetal forms. Like animals, they feed upon organic matter. Their substance is rich in nitrogen, has a savory meat-like taste, and when decomposing gives out a strong, cadaverous smell. They absorb oxygen and disengage carbonic acid, and by their avoidance of light they present a striking contrast to the rest of vegetation. Nevertheless, careful observation shows that they consist of parts, and

crested agaric—*Agaricus cristatus.* 20. Mitral helvela—*Helvela mitra.* 21. Tuberous agaric—*Agaricus tuberosus.* 22. False puff-ball—*Scleroderma cepa.* 23. Large-stemmed peziza—*Peziza macropus.* 24. Green and yellow agaric—*Agaricus psittacinus.* 25. Crisped helvella—*Helvella leucophæa.* 26. Reticulated peziza—*Peziza reticulata.* 27. Yellow spathularia—*Spathularia favida.*

perform functions, by which they are allied to all other plants and closely related to one of the largest groups of the vegetal kingdom. They stand, in fact, at the head of the class of fungi, of which there are at least as many species as of all flowering plants put together.

These singular forms, though low in the scale when compared with the green and blossoming world around us, are yet complex and imposing when contrasted with the world of plant-life revealed by the microscope. They have a distinct vegetative system, and a highly-organized reproductive system. On examining the common cultivated mushroom, a species which grows wild in meadows and pastures, these separate systems may be readily distinguished. The vegetable mould or decaying substance on which it grows is penetrated with grayish-white delicate interlacing filaments which are represented by the root-like fibres shown in Fig. 1. This webby mass constitutes the vegetative portion of the plant. It is called the *mycelium*, or, among dealers, the spawn, as by its means the plant is propagated in cultivation. In a dry state it may be kept dormant for a long time, and will grow into a perfect plant under the influence of heat, moisture, and other favoring conditions.

From this mycelium arises the reproductive system—that portion of the mushroom which is seen above-ground and which may be compared to the inflorescence of higher plants. It consists of the long thick stem or *stipe* and the umbrella-like top, called the cap or *pileus*. On the lower surface of this cap vertical plates are seen radiating from the stem, though not connected with it. These plates are known as *gills*, and in a living specimen they will be found covered on all sides by a delicate membrane called the *hymenium*. Upon this hymenium are borne the reproductive bodies or *spores*, which are analogous to seeds.

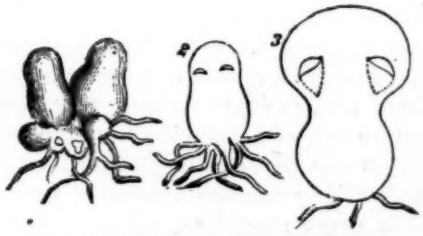


FIG. 2.—MUSHROOM IN PROCESS OF GROWTH.

To make our conception of the structure of this mushroom more complete, we will trace its growth from the beginning. The first visible portion is the mycelium, at certain points of which there appear, at an early stage, round tubercles not larger than a mustard-seed, which rapidly increase in size, push through the soil, and become more or less elongated, resembling the shaded cut in Fig. 2. There is yet no external sign of cap or gills, but a section of the tubercle will reveal

a pair of dark-colored spots near the top (*see* 2 and 3, Fig. 2), which mark the position of the future gills. A little later the cap begins to take shape, the gills develop, and a membrane may be seen stretching from the stem to the edge of the growing cap. As maturity approaches, this membrane is ruptured and forms a ring around the stem, as shown in Fig. 3. This membrane is called the veil or

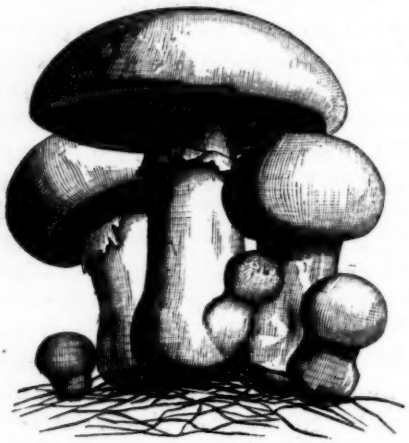

FIG. 3.—COMMON MEADOW MUSHROOM.

*volva.* The parts to be borne in mind, then, are the mycelium or vegetative portion, and the stem, cap, gills, hymenium, ring, and volva, all of which belong properly to the reproduction of the plant, and all, except the hymenium, may be readily traced in Fig. 3.

If, when the mushroom is mature, you cut off the stem close to the gills, and place the cap, gills downward, upon a sheet of paper for a few hours, or all night, it will leave behind a likeness of itself in the shape of radiating lines that correspond to the spaces between the pairs of gills. These lines are formed by minute microscopic spores that have been thrown down in profusion from the hymenium, and in greatest number from the opposed surfaces of the gills. In making the experiment with this mushroom use white paper, but for light-spored species black paper should be taken. These little germinal bodies are cellular in structure, and of the extremest minuteness; thousands of them are required to form a body the size of a pin's-head. Their color is constant, and is used as a means of identification; but among the higher plants color is a character that cannot be thus relied upon. The spore is a simple cell, and the entire mushroom is cellular in composition. The delicate threads of the mycelium are formed of rows of cells placed end to end, and microscopic inspection of thin slices from the stem and cap show, that they also are composed of cells alone.

The rank of this plant in the vegetal kingdom is settled by the direction of growth of its vegetative system and by the nature of its tissues. All flowering plants, as well as the ferns and mosses, have their vegetative part made up of root, stem, and leaves. The root grows downward and the stem upward. But the growth of the mycelium, the vegetative system of the mushroom, is horizontal; there are no signs of such organs as root and stem. In this respect it is on a level with lichens and sea-weeds, and belongs at the foot of the scale in vegetation. As respects the nature of its tissues and the absence of woody fibre in its composition, it resembles all the flowerless plants except ferns. But where are its immediate kindred? Have mushrooms no nearer relations than mosses, lichens, and sea-weeds?

To answer this question intelligently we must further observe the structure of fleshy fungi. In the common mushroom, as we have seen, the hymenium is spread out upon the lamellated structure of the gills —an arrangement, however, which is not general. It is peculiar to a single group known as agarics. This group has also the further general characteristic of preferring to grow in shady places. But in this latter respect the common mushroom is an exception. In its wild state it flourishes best in meadows and pastures. Its scientific name is composed of two words: one tells us the immediate group of toadstools to which it belongs, and the other expresses this exceptional feature in its constitution. The one which is put first is its family or surname, *Agaricus;* and the specific name, or what we may call the "given" name, is *campestris* (meaning field). These names are written in Latin for the convenience of the botanists of different nations speaking different tongues, but for whom the Latin is a common medium of communication.

FIG. 4.—POLYPORUS GIGANTEUS (reduced).

Now, the structure of the under portion of the cap in some toadstools is porous instead of lamellar. The surface of the spore-bearing hymenium is multiplied by means of pores or tubes which penetrate the substance of the cap, as seen in Fig. 4. Two stemless species of this sort are shown in the plate as growing upon an old tree.

Sometimes this under surface is seen to be quite smooth, or it

may be simply wrinkled; sometimes it is warty or prickly, and in Fig. 5 it is represented as covered with spines. Again, in some species of fungi, the hymenium, instead of being situated externally, is inclosed in a membrane which bursts when its spores are ripe, and scatters them like a cloud of smoke to the winds. Of such is the puff-ball, Fig. 6, with which everybody is familiar.

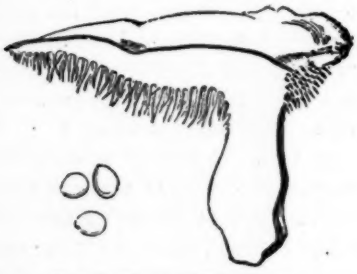

FIG. 5.—HYDNUM REPANDUM.

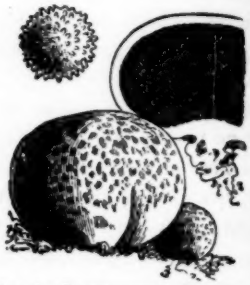

FIG. 6.—SCLERODERMA VULGARE.

These fleshy forms, however, although very numerous, constitute but a small part of this immense group. But most of the species included in it are either quite invisible, or else the parts which characterize them as fungi are so small as to be indistinguishable. The feature by which a fungus may always be known is the mycelium. Every plant of which this structure forms a part, spreading its web throughout the substance on, or in, which it grows, belongs among fungi. They differ among themselves in such comparatively unimportant respects as the mode of growth of the hymenium, or the degree of complexity of the reproductive system, but mycelia and spore production are their essential characters. In these diminutive organisms, the delicate mycelium is so minute as to traverse living plants and the pores of solid wood. The potato-rot is such a fungus—a sort of mould—the mycelium of which grows rapidly, penetrating the leaves, stem, and tubers, and causing quick decay. Dry-rot in timber is occasioned by the penetrating mycelium of fungi. The yeast and vinegar plants are submerged mycelia. The mildews, rusts, and smuts of grain—those scourges of the farmer—are all fungi. Their minute mycelium penetrates and destroys the tissues of plants, and, bursting through the cuticle, covers them with myriads of their orange, brown, and black spores. All those black, pustular growths seen on dead wood, bark, twigs, and leaves, and the whole tribe of moulds that cover every substance exposed to dampness, are fungi. Not only do these fungi ravage the living and the dead, but they fill the air with the countless myriads of their spores. These subtile particles, "invisible to the naked eye, and light almost as vapor, are continually floating in the air we breathe, or swimming in the water we drink, or lying amid the impalpable dust and sand of the soil, waiting the presence of warmth

and moisture to burst into independent life. Myriads of the minute germs of moulds fasten upon various domestic articles, or dance about in the air-currents of our apartments, moving rapidly up and down and in every direction. The microscopist and the chemist have demonstrated the existence of these germs in greater or less quantity in the air of both country and town, out-of-doors as well as in-doors; and Prof. Tyndall by calling in the aid of optical analysis has, on this point, made assurance doubly sure. If we venture for a moment to imagine the overwhelming number of seeds which the different species of fungi must disseminate in the course of a single year—if we consider that each individual of the common puff-ball contains upward of ten million seeds, and these so small as to form a mere cloud when puffed into the air; and that a single filament of the mould which infests our bread and preserves will produce as many germs as an oak will acorns, so that a piece of decaying matter, not two inches square, will scatter upon the air, at the slightest breath of the summer breeze or the gentlest touch of an insect's wing, as many seeds, quick with life, as all the oaks of the country will produce acorns in a twelvemonth—if we take these things into consideration, it is not too much to suppose that the seeds of fungi must be ubiquitous, and from their excessively minute size penetrate into every place, even into the stomachs and other parts of animals. Indeed, the difficulty seems to be to imagine a spot without them."

But, in looking up the relatives of the mushroom, we have been led too far away from the study of its structure. Recurring to the species with which we began our study, and a cluster of which, at different stages of growth, is represented in Fig. 3, let us inspect it once more, and make sure that we have a clear notion of all its parts. Observe the mycelium at the base, the stem, the unbroken volva in the young ones, the beginning of its rupture in a more advanced stage, and, finally, at the end of growth, the fully-developed cap, with its gills, and the ring left by the volva upon the stem. After this account of its structure, its specific description should be quite intelligible to anybody, and ought to suffice for the ready recognition of the living plant. It is as follows:

*Cap* fleshy, either smooth or scaly; its color is white, or tawny, or smoke-colored, or brown; *gills* free, when first formed pale, then changing to flesh-color, then to pink, next to purple, and, at length, tawny-black; *stem* white, full, firm, varying in shape, with a white persistent ring. Spores brown-black; volva quickly disappearing. In his recent work on "Fungi and their Uses," Cooke says of this plant that the color of the spores and gills, and the presence of the ring, are characters that never vary, but the color and scaliness of the cap, and other minor features, are variable; and, furthermore, he enjoins that it must not be sought in the woods. Its proper season is September and October.

There is another common, though much coarser species of edible mushroom, often mistaken for this one, and sold as such by dealers. Although it resembles the cultivated species, it may be easily distinguished by its big, ragged ring (Fig. 7), its pithy stem, tending to hollow, and its gills of a dirty-brownish white. It is also much larger,

FIG. 7.—AGARICUS ARVENSIS.

being sometimes more than a foot across, while the common mushroom rarely exceeds three or four inches; in good specimens its top is smooth and snowy white, and it turns of a brownish yellow as soon as broken. It is known as the snowball, or horse-mushroom (*A. arvensis*).

On the subject of distinguishing poisonous species, Mr. Cooke says that there is no golden rule which will enable us to tell at a glance the good species from the bad. The only safe guide lies in mastering, one by one, the specific distinctions, and increasing the knowledge through experience, as a child learns to distinguish a filbert from an acorn, or a leaf of sorrel from one of white-clover. The characters of half a dozen good, esculent species, he says, may be learned as easily as the ploughboy learns to discriminate as many species of birds. He tells us, moreover, that it is not enough to avoid poisonous species, but that discretion should be used in preparing and eating good ones. They change so rapidly, that even the cultivated mushroom, if long kept, is unfit for use. Nor is it enough that they be of good species and fresh; but plenty of salt must be used in their preparation, to neutralize any deleterious property, and pepper and vinegar are also recommended as advantageous.

Encouraged by these statements, from so distinguished and reliable an authority, we venture to present the pictures and descriptions of three more of the most highly esteemed of the edible fungi, which are common in the United States.

THE PARASOL AGARIC.—Of this esteemed mushroom, Cooke remarks that it is in high request in Italy and France, and is also eaten in Austria, Germany, Spain, and England. It is easily identified. It has a fleshy cap, ovate when young, then bell-shaped, and afterward expanded and blunt-pointed. The extreme forms are shown in Fig. 8. The cuticle is more or less brown, and torn into patches or scales, except over the apex, these scales separating toward the margin. Flesh, white. Gills unconnected with the stem, and fixed to a collar on the cap around its top. Ring, persistent, loose on the stem. Stem six or eight inches high, tapering upward from a pear-like bulb at the base, hollow, with a loose pith, whitish brown, but more or less variegated with small and close-pressed scales.

FIG. 8.—THE PARASOL AGARIC (*Agaricus procerus*).

Whenever a mushroom on a long stalk, enlarged at the base, presents a dry cuticle, more or less scaly, is darker colored over the blunt apex, has a movable ring and white gills, it must be the parasol agaric, and may be eaten without fear.—ROBINSON.

Chantarelle (*Cantharellus cibarrius*). Of this species Cooke says: "It has a most charming and enticing appearance and odor. It is almost universally eaten in all countries where it is found, England excepted." Trattinnich says of it, "Not only this same fungus never did any one harm, but might even restore the dead."

When young, its stem is white and solid, but becomes hollow and yellow. It is tapering, and passes into the substance of the cap, which is of the same color. The cap is lobed and irregular in shape (Fig. 9); its margin, at first curling inward, becomes expanded and wavy. The gills, or veins, as they are called, in this species, are thick, crooked, not compact, running some way down the stalk. Flesh white, fibrous, dense, with a fruity odor. Color, yellow, like yelk of eggs;

deeper on the under surface. When raw, it has the pungent taste of pepper. Spores, of a pallid, ochre-color. It may be found from June to October.

Fairy-ring Champignon (*Marasmius oreades*). This delicious fungus (Fig. 10) grows in pastures in rings, or parts of rings, and may be known by the following characters: Cap smooth, fleshy, convex, rather blunt at apex, more or less compressed, tough, leathery, elastic, wrinkled; when water-soaked, brown; when dry, buff, or cream-color, the apex often remaining red-brown, as if scorched; gills free from the stem, distant, swelling out in the middle, the same color as the cap, but paler; stem equal, solid, twisted, very tough and fibrous, of a pale, silky-white color. This genus is much addicted to dead leaves. —COOKE.

FIG. 9.—CHANTARELLE (*Cantharellus cibarrius*).

Another very acrid species (*A. urens*) has a similar appearance, but the gills are narrow and much crowded.

While all fungi are cellular in structure, they yet present a great variety of consistence. Some assume a corky or leathery firmness, while the substance of others is a mere watery pulp or gelatinous scum. Some are interlacing fibres, spread like a veil over decaying matters, while others are hard and tough like wood. They vary equally in taste and form. The cultivation of fungi for esculent purposes is confined to a single species, *A. campestris*, although, according to Cooke, there is no reason why others, for instance, *Marasmius oreades*, and the morel (*see* plate), should not succeed equally well. An unaccountable circumstance in this culture is the impossibility of growing mushrooms from spores. It is the mycelium or spawn which is always planted by gardeners, from which the production of mushrooms is simple enough, but how to obtain mycelium from spores is still a mystery. Other species present a similar difficulty, as the following statement from "Fungi and their Uses" will illustrate:

"A friend of ours, some years since, was fortunate enough to have one or two specimens of the large puff-ball (*Lycoperdon giganteum*) growing in his

garden. Knowing its value, and being particularly fond of it when fried for breakfast, he was anxious to secure its permanence. The spot on which the specimens appeared was marked off and guarded, so that it was never desecrated by the spade, and the soil remained consequently undisturbed. So long as he resided on the premises, he counted upon and gathered several specimens of the puff-ball, the mycelium continuing to produce them year after year. Burying a ripe specimen in similar soil, and watering the ground with an infusion of fresh specimens, has been tried without success."

FIG. 10.—FAIRY-RING CHAMPIGNON (*Marasmius oreades*).

Mushroom-growing, as carried on in some parts of France, is so extraordinary as to deserve mention. In the vicinity of Paris there are extensive caves formed by stone-quarries long since abandoned. In these caves, sixty or seventy feet underground, and extending great distances, the temperature is equal and the air moist, and here mushroom-beds are made, and immense quantities of the plant are grown for home and foreign markets. An idea of the magnitude of the business may be formed when it is known that one proprietor has twenty-one miles of beds, another sixteen, another seven, and so on through a long list. In the ramifications of the cave of Montrouge (Fig. 11), just outside the fortifications of Paris, there are six or seven miles' run of mushroom-beds. It is entered through a circular opening, like the mouth of a well, and the only mode of descent is down a shaky pole, furnished with cross-bars, the base of which rests in darkness sixty feet below.

A gentleman who visited this cave remarks:

"I had an idea that one might enter sideways in a more agreeable manner, but it was not so. Down the shaky pole my guide creeps, I follow, and soon reach the bottom, from which little passages radiate. A few little lamps, fixed on pointed sticks, are placed below, and, arming ourselves with one each, we slowly commence exploring dark, still, tortuous passages. . . . On each hand are little narrow beds of half-decomposed stable-manure running along the wall, that have not yet been spawned. . . . Wherever the rocky subway became as large as a small bedroom, two or three little beds were placed parallel to each other. They are about twenty inches high, and were dotted all over with mush-

rooms no bigger than peas. . . . Every thing looks quite neat, not a particle of litter being met with."

Of the way mushrooms are usually cultivated, and the various modes of cooking them, it is not our purpose to speak. Whoever

FIG. 11.—MUSHROOM CAVE, SEVENTY FEET BENEATH THE SURFACE, AT MONTROUGE, NEAR PARIS.

wishes to study these subjects will find them fully treated in Robinson's "Mushroom Culture." To give an idea of the rich stores of

mushrooms in this country, we quote from a communication of the late Dr. Curtis, of South Carolina, in reply to inquiries of Rev. C. Berkeley:

"My experience with eatable mushrooms runs back only ten or twelve years. As I had grown up with the common prejudices against them, and had no lack of wholesome food, I had passed middle life before having once tasted a mushroom." Under the guidance of Mr. Berkeley he became interested in them, and overcame his timidity, and, at the time of writing, he adds: "I can safely say that I have eaten a greater variety of mushrooms than any one on the American Continent." After describing his mode of experimenting, and the various species he had proved, he continues: "I have collected and eaten forty species found within two miles of my house. There are some others within this limit which I have not yet eaten. In the catalogue of the plants of North Carolina you will notice that I have indicated 111 species of edible fungi known to inhabit this State. I have no doubt there are forty or fifty more, as the Alpine portion of the State, which is very extensive and varied, has been very little explored in search of fungi.

"In 1866, while on the Cumberland Mountains in Tennessee, a plateau less than 1,000 feet above the valleys below, although having very little leisure for examination during the two days spent there, I counted eighteen edible fungi. Of the four or five species which I collected there for the table, all who partook of them, none of whom had before eaten mushrooms, most emphatically declared them delicious. On my return homeward, while stopping for a few hours at a station in Virginia, I gathered eight good species within a few hundred yards of the depot. And so it seems to be throughout the country. Hill and plain, mountain and valley, woods, fields, and pastures, swarm with a profusion of good, nutritious fungi, which are allowed to decay where they spring up, because people do not know how, or are afraid, to use them.

"I have known no instance of mushroom-poisoning in this country, except where the victims rashly ventured upon the experiment without knowing one species from another. There are families in America who have brought with them from Europe the habit of eating mushrooms, but I have not met with any whose knowledge of them extended beyond the common species, called pink-gills, in this country. Several such families live near me, but not one of them was aware, until I informed them, that there are other edible kinds. When I first sent my son with a fine basket of imperials to an intelligent physician, who was extravagantly fond of the common mushroom, the lad was greeted with the indignant exclamation: 'Boy, I wouldn't eat one of those things to save your father's head!' When told that they were eaten at my table, he accepted them, ate them, and has eaten many a one since with all safety, and with no little relish."

Among our best and standard mushrooms, Dr. Curtis mentions the meadow, the horse, and umbrella mushrooms, but adds:

"Tastes differ on these things as on fruits and vegetables; some putting one, some another, at the head of the list, though fond of all, and ever ready to use any of them, as one who prefers a peach may yet relish an apple. There are some among us who regard the umbrella-mushroom as fully equal to the meadow-mushroom, and I am of the same opinion. When boiled or fried, it truly makes a luscious morsel. I mention, in this connection, that this species here bears the name of nut-mushroom, from a quality that I do not find mentioned in the books

which describe it. The stem, when fresh and young, has a sweet, nutty flavor, very similar to that of the hazel-nut. Its flavor is so agreeable, that I am fond of chewing the fresh stems. From this peculiarity, in connection with its movable ring, its form and colors, I deem it a perfectly safe species to recommend for collecting."

Dr. Curtis says, however, that the same species varies very much in flavor in different regions, owing probably to differences of soil, exposure, shade, moisture, or temperature. He has found perfectly sound pink-gills with unpleasant odor and taste, and horse-mushrooms that were "perfectly detestable." But, whether such exceptional specimens are poisonous or not, he thinks of no consequence, because no human being could be induced to swallow them.

## ARE LANGUAGES INSTITUTIONS?

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WHILE the present century has witnessed a truly wonderful advance in the study of languages, it has not yet yielded equal results for the science of language. Comparative philology has thus far borne off the palm over linguistics. The classifications of human speech, the historical development and divarication of languages, the processes of phonetic change, are understood to a degree of which our fathers had no conception; but the coördination and explanation of all these facts, the recognition of the forces whose workings underlie and produce them, and of the ways in which those forces act—on such subjects there is far from being that general agreement of opinion which ought to mark a matured branch of study.

To quote a few instances: while the Boppian view of the making of grammatical forms by collocation, combination, and integration of originally independent elements, may be regarded as the leading and orthodox one in the modern school of philology, there yet are scholars of rank who deny it, and assert, instead, that endings were created in their separate entity and office along with the bases to which they are attached, or sprouted out from the latter by the working of some mysterious internal force. Most linguistic scholars hold that the development of a grammatical system has been a work of ages, always going on and never finished; but at least one celebrated and admired authority declares the whole essential structure of a language to be produced "at a single stroke." It is the prevailing belief that the world is filled everywhere with families of related dialects, and that a family of languages, as of individuals or of races, arises by the dis-

persion and differentiation of a unitary stock. One or two teachers of the highest popular repute ask us to believe, instead, that language had its beginning in a condition of indefinite dialectic division, and has been always tending toward unity—that there are, as an exception, two or three real families, and no more, these being the result of peculiar and unexplained processes of arbitrary concentration in the remote past; and another bold doubter makes a great stir by denying the ordinary family-tree theory of linguistic kinship, and putting in its place a theory of wave-motion, propagated from a centre. Some hold (more or less consistently) that language is a natural organism, growing by its own forces and its own laws, with which men cannot interfere: others declare it an instrumentality, produced in every item by the men themselves who use it. Some write of it as a human faculty or capacity, like sight or hearing, as a gift, as identical with thought or reason, as the one distinguishing quality of man. Others regard it as one of the outcomes of a variety of faculties and impulses, by all of which man is far removed from the lower animals; as one which, under normal conditions, is sure to show itself, but which may, by the mere force of external and accidental circumstances, be thwarted, without impeachment of man's nature, but only of his education. Some maintain that the child learns his own language; others strenuously deny that there is any teaching or learning about it. Some, once more, declare the study in which they are engaged a physical science, while to others it seems as truly an historical or moral science as any other branch of the history of man and his works.

Now, with regard to all these matters of discordant opinion, only one side can possibly be in the right. We may be able to excuse those who take the wrong side, seeing where they are misled by looking at the facts from a false point of view, by misconceiving the meaning of a term or forgetting its double application, by omitting to take into account some decisive consideration, by overlooking important items of evidence, and so on; but wrong they are, nevertheless. And it is truly unfortunate that, just upon points of the most fundamental importance, the linguists should be so at variance with one another. Surely the study of language, so extolled on all sides for the strictness of its methods and the solidity of its results, might have gone so far by this time that its votaries should be able to give a nearly unanimous opinion, for example, as to what a word is in relation to a conception, and to follow that opinion logically and consistently out to its consequences. One grand reason for the discordance has been, to be sure, that linguists were so busy with the infinite and urgent details of their work: details which they have not yet begun to exhaust—hardly, even for the majority of human languages, to look over and get well in hand.

Germany is the home of philological and linguistic study; but the Germans are rather exceptionally careless of what we may call the

questions of linguistic philosophy, or are loose and inconsistent in their views of such questions; hardly seeming, in many cases, to be aware that there are antagonistic doctrines before them, one of which ought to be, and must finally be adopted, to the exclusion of the other. There needs to be, perhaps, a radical stirring-up of the subject, a ventilation of a somewhat breezy, even gusty, order, which shall make words fly high, and dash noisily against one another, before agreement shall be reached. If so, the sooner it is brought on, in whatever way, the better; and they are no true promoters of the progress of the science who strive to smooth things over on the surface, and act as if all were serene and accordant below.

Amid manifold minor diversities, and half-views and compromises innumerable, opinions respecting language seem to be divisible into two principal opposing classes, which may be termed (rudely, and without intended offense to the sensibilities of the adherents of either) the positive and the sentimental, or the common-sense and the metaphysical. The latter class tends toward an admiring contemplation of language, in its comprehensive relation to the human mind and human progress, and toward its study in and through the processes of mental action that underlie its production and use. The other class plants itself upon the consideration, first of details, and then of their combined result; it begins with the audible sign—the word—and works from this toward the intellectual process which it represents. The one strives after profundity, brings in its illustrations from remote periods and languages, and forms grand and striking views; the other aims at simplicity, at general intelligibility, at moderation, and rejoices in the overthrow of exaggerated and illusory opinions. It is by no means easy to characterize the two opposing tendencies fairly in a sentence or two; and I would not at all claim that the description here given is not tinged with the prejudices of the describer. One may acknowledge the influence of such prejudices in drawing up a general account of the questions at issue, while yet he may believe himself capable of examining and discussing, with entire fairness, any detailed views, any distinct statements or arguments, brought forward by the opposing party.

As to which of these two general tendencies is at present the prevailing one among the professional students of language, there can be no reasonable doubt: it is the one here called the sentimental or metaphysical. How long this is going to be the case is another and a more difficult question. In the prevailing confusion of discordant opinions, and carelessness about the discordance, described above, comparatively few have declared themselves; and there is probably light enough abroad to bring out men's decisions prevailingly on the right side when once they can be led to reason themselves into clearness and consistency of opinions. Meanwhile, the unlearned popular view of speech, that of the general body of cultivated people, that

which has most votaries among the students of physical science, and those who approach the subject from the side of general anthropology, is rather of the opposite type. That the division bears this aspect ought, it should seem, to tell against the latter doctrine; but there is no good ground for regarding the fact as decisive, for, until the linguists are agreed among themselves as to fundamental points, they have no common vote to throw.

For myself, I hold the more popular doctrine to be also the truer, and, in the proper sense, more philosophical; and the other to be founded on the insecure basis of combined misapprehension and exaggeration. And I propose to give here, in as brief a form as it is possible, my reasons for thus holding.

Every thing in the study of language, as in most other studies, depends upon the way in which one approaches the fundamental questions. In my opinion there is no other way here so secure and so fruitful as that of inquiring what our own speech is to us, and why; how we came by it, and by what tenure we hold it. The general linguistic philosophy we profess must, first and above all things, be consistent with the most accessible facts of present living language; we may not be able to explain these from themselves alone, but our doctrines must at any rate not go counter to them. If physical science has been worth any thing for its influence upon other sciences, it has been by inculcating its method of investigation, to make the utmost of what is immediately under our eyes, and reason cautiously back from the present into the past.

Nor, in getting at language from this side, must we undertake to deal with it as a body or total, lest we lose ourselves in glittering and indefinite generalities. We must take up only so much as we can hold in the hand, as it were, and deal with competently. Let us try the single word *book*. It is to us the sign of a very complex conception, but one which needs no defining. How came we by it? Every other linguistic community in the world that has the thing has also a name for it, but the names are all different—*livre*, *libro*, *buch*, *biblion*, *kniga*, *kitâb*, *pustaka*, and so on—let us say a round hundred of them. Why do we use for our conception this one of the hundred? There is but one answer to this, a common-sense answer, which no philosophy can possibly reason away. We learned the word, hearing it used during the period when we were engaged in learning things and their names, used over and over again, and in such connections as showed us what it meant; we learned to reproduce the series of sounds, and to associate it with the conception, just as we could have learned to reproduce and associate any other of the hundred, or any one of a thousand other signs—as a motion of the hand, or a square mark. There is absolutely no tie of union to us between the sign and the thing signified save this mental association, artificially formed—that is to say, brought about under the guidance of others, after their

example, not by any inward impulse. Some of us, indeed, know that the word has a curious history—that it is akin to *beech*, and for the reason that beechen staves or tablets were the first material used by our rude ancestors for cutting runes upon. But this is merely a matter of learned curiosity; our knowledge or want of knowledge, our belief or disbelief in the explanation when given us, has nothing to do with our use of the term *book;* we use it because others—those with whom it is our lot to have to do in life—also use it, because we can communicate with them by means of it. If we, though of English blood, had happened to be born at Paris, at Rome, at Cairo, at Peking, we should either have learned to use a different word from this, or another besides it, in the same sense and for the same reason—even as in English-speaking communities, especially in America, descendants of half the races under heaven use *book* as their "native" sign, knowing absolutely nothing of any other.

But what is thus true of *book* is true also of every other sign of which our language is composed, unless we may have committed in a few instances that rare act, the coining of a word. And this is already of itself enough to show that in a perfectly proper—indeed, in the only genuine—sense, our words are arbitrary and conventional signs: arbitrary, not because no reason can be given for the assignment of each word to its use, but because the reason is only an historical, not a necessary one, and because any other of the hundred current, or of the ten thousand possible, signs might have been made by us to answer precisely the same purpose; conventional, not because it was voted in a convention (what that we call "conventional" ever was so?), nor because men came to an explicit understanding about it in any other way, but because its adoption by us had its ground in the consenting usage of our community. There is no way of denying these two epithets to language, except by misunderstanding their meaning.

Moreover, it is not the case that the learner gives birth first to an independent and adequate conception of a book, and then merely accepts from others the name by which he shall call it. For the "inner form," not less than for the outer sign, he is dependent on his teachers. He would not, indeed, even begin to use the word if he had not formed some sort of an idea of a thing which it stood for; but he knows next to nothing about the thing; it is to him a mystery of which he only later obtains the key, and which he does not fully understand till after he has studied the history of civilization, a whole chapter of which is, in a manner, epitomized in the single term. And all this is given him in measure, as he is prepared to receive it, by the teaching of others. A further example or two will show this dependence still more clearly. The idea of *planet* came down to us as defined and named by our instructors, the Greeks, and named from the most superficially obvious property of the objects designated, that of "wandering," or moving amid the other stars. No uninstructed

person would single out a class of heavenly bodies to call by such a name; many races have never formed the conception. To those who gained learning enough, the meaning was further enriched by connection with the Ptolemaic system of cycles and epicycles. Then, as by a touch, Copernicus altered the whole aspect of the word, and changed the classification which it represented, ejecting the sun and moon, and taking in the earth. And all this is now used to help give shape to the at first dim and formless idea, which the language-learner is made to entertain along with the sign which is taught him. Once more, the child is made to count, and in the process his conceptions of number are cast into a decimal shape, one in which each higher factor is made up of ten of the next lower, till he comes to feel that such tenfoldness is a natural characteristic of enumeration. Yet, if we inquire whence comes this particular shape, we find it growing out of the simple fact that we have two hands, with five fingers on each! So utterly extraneous and accidental a cause as this, as turned to account by the simple races who laid the deep foundations of our mathematics, determines the "inner form" assumed by the mathematical conceptions of each new member of our race; of course, quite without his knowledge.

So it is all the way through language. Along with and by means of words, the young learner is made to take in the ideas which the knowledge and experience of older men have shaped; he accepts the current classifications and abstractions of his community, at first only imperfectly, then with fuller and more independent action of his own, till finally he grows up to the stature of his language, and has, at least in some departments, nothing more to learn of those about him. At the beginning, and in less degree later, he was so hurried on by the superiority of his instructors in knowledge and mental development, that he had neither leisure nor inclination to be original; now he becomes in his turn a teacher, and also a shaper. By his action and that of his fellows, the common instrument of expression undergoes a constant slow change. Their new knowledge has somehow to be worked in. It is done partly, as in the case of *planet*, by reshaping the conceptions contained in old words, and shifting the boundaries of old classifications; partly by the cognition of new particulars which are brought under old names, expanding so far their contents—as when Uranus and Neptune are brought into the class of *planets*, and the satellites of Jupiter and Saturn make a class for the formerly unique appellation *moon;* and partly by providing new names for objects, products, qualities, relations, before unperceived, or so dimly apprehended as not to seem to call for expression. And the provision is made in part by deliberately going to other tongues and borrowing material from them (so *Uranus*, *Neptune*), or else by forming new compounds of native material (so *steamboat*, *railroad*), or, very frequently, by mere transfer of old words to new uses, substituted or ad-

ditional. By these and other similar means, language is continually adapted by its speakers to express the modified content of their minds. At the same time, it suffers change of a yet more intimate and unconscious kind as an instrument; its phonetic shape being rendered more manageable, and its grammatical shape as well; new words of relation are made, by the attenuation of more material elements, and now and then, in a kindred way, a new form.

So far as a language is handed down from generation to generation by the process of teaching and learning, it is stable, and by this means it does remain nearly the same; so far as it is altered by the consenting action of its users, it is unstable, and it does in fact change. Examine any language, and you will find it different from its predecessor; different in a variety of items of the kinds instanced above, each of them being obviously the work of the speakers, and showing no signs of the presence of any other force. In the present stage of what we call the growth of language, nothing takes place which is not the effect of human agency; the only obscurity about it grows out of the fact that there is involved the consenting action of a community, since language is a social institution, and exists primarily and consciously for the purpose of communication. But if this is so nowadays, then it was so in the period next preceding, and in the one before that; and so on, until the very beginning is reached. For we have no right to assume unnecessarily that the processes of growth have essentially changed; that is to say, if the methods of word-making and form-making as exhibited in the historical period are sufficient to account for the whole existing material of speech, we are not authorized to postulate others.

And such is the case. Forms have been made, through all the historical periods, by the combination of independent elements, and the reduction of one of them to a formal value by means of changes of form and changes of meaning, such as are exhibited in every part of language; and this action, varying in kind and degree under the changing circumstances of developing speech, can never, so far as at present appears, be proved insufficient to explain the structure of language. If there are problems of structure as yet unsolved, they may be expected to yield to more skilled investigation; or, if they do not, it will be presumably because of the loss of needed evidence. The name-making process implies only the christening of a formed idea, the provision of a sign which shall henceforth be associated with a particular conception, and used to represent it in social intercourse and in the operations of thought. And the sign is obtained just where it can be most conveniently found, according to the circumstances and habits of each particular community. There is nothing approaching to necessity in an etymology. It is only a tie of convenience that connects the new name with its source: in the case of *book*, the tie of historical development out of an accidental selection of material; in

*planet*, that of intended, but palpably insufficient description; in *Uranus* and *Neptune*, of learned and reflective selection, under government of the same regard for analogy which controls also the most unconscious and popular choice of appellations; and in *decimal*, no one has yet been skillful enough to find out what. But, known or unknown, sufficient or insufficient, learned or popular, it is all one, so far as regards the practical uses of speech; when once established in use, the name, from whencesoever derived, is good enough for its office. It were vain indeed to be particular about the source, when the use is going to depend, with each new learner, on an artificially-formed association alone.

Now, how should it enter into the mind of any one to regard words thus won, thus kept in life, thus liable to alterations of every kind in the mouths of their speakers, as any thing more than the instruments, the outward equipment, of thought? Thought is the action of the mind, in apprehending, comparing, inferring; every word is an act of the body, and of the body only; performed, indeed, as all the voluntary acts of the body are, under the direction of the mind, but no more the work of the mind than are crooks of a finger, or brandishings of an arm, or kicks with a foot. There is no more immediate connection of the apparatus of thought with the muscles of utterance than with those of facial expression or of gesture. Talking is just as much thought as dancing is; not one whit more. All the arguments used to show the impossibility of mind-work without speech are, so far as I can see, such as would also prove the impossibility of manual work without tools and machines, of mathematical work without written signs.

If it be asked how the mind comes to equip itself with this instrumentality, the answer is ready and easy: it does so under the impulse to communication. That language should owe its origin and maintenance to a cause so extraneous to the soul, and so superficial, is repugnant to the prejudices of many; yet I do not see how the truth of the doctrine can be successfully controverted. It is in accordance with all that we know of the history and present use of language, and, not less, with all that we know of the development of man's powers in other departments. Through all its existence, speech is primarily and above all a social possession, its unity made and preserved by mutual intelligibility, all its items and their changes requiring the adoption of a community before they become language at all. Those who, by isolation or physical defect, are cut off from communication with their fellows, do not speak, and have no inclination to speak. And, especially, communication is the only inducement to which every human being, at every grade of culture, is fully accessible. The great majority, even of speaking, civilized men, do not realize that language is any thing to them but a means of communication; and to ascribe to the uncultivated man a power to foresee that expression will furnish

his mind an instrument to work with, and be to the race an indispensable help forward in the career of improvement, is to do him a great deal more than justice. This is the way in which in general the powers of man have been drawn out and educated; the art of writing came, in like manner, from attempts at another kind of communication; machines came, one item after another, in the struggle of man to supply his physical needs. We are short-sighted beings, and never able to look more than one step ahead, but we have the power of putting each new step beyond its predecessor, and are surprised by-and-by to see how far we have come, how much we have attained that we had neither expected nor foreseen.

If these views as to language are true, then the marked analogies of languages with institutions are patent and undeniable. A language is a body of usages; it has its main occasion and usefulness in connection with the social life of a community; it is a constituent part of the civilization of its community, worked out, like the rest, by long-continued collision and friction between man and his circumstances, gradually accumulated by the contributions of each member of a race through successive generations, and handed down by a process of teaching and learning. Let a child of European parents be brought at birth into an Indian wigwam, and grow up among Indians only; and his life in all its parts will be Indian—his food, his occupations, his amusements, his knowledge, and his beliefs—and, along with the rest, his language also; while the African, for instance, born and bred in an American community, shows in all these same respects accordance with that particular class of Americans among whom his lot is cast. This by no means implies that there are no such things as race-differences of capacity and disposition, even as there are wide individual differences between members of the same race: the white man makes, perhaps, a somewhat peculiar kind of Indian, the African a peculiar kind of American; yet each acquires the civilization, language included, of the race with which he grows up, and shows his race-characteristics, as they their individual characteristics, inside of that.

All names are imperfect, and have their unsuitable, as well as their suitable suggestiveness in connection with every new object to which they are applied; but I hold, and with the utmost confidence, that there is no general name so truly descriptive of a language as *institution*—none which takes into account so many of its essential characteristics, or marks so distinctly its place among the possessions of its community. The word, no doubt, offends some, and seems to others derogatory to the dignity of its subject; but I believe that the more the real nature and office of language are understood, and the more established and consistent the linguistic views of the educated become, the more its truth will be acknowledged. I have used it often, partly in a kind of defiance to those views which are decidedly

opposed to what it implies; I shall be ready to abandon it when its impropriety is proved by fact and argument.

The great obstacle, as it seems to me, to the prevalence of consistent and correct views concerning language, is the ambiguity of the word *language* itself. It means two entirely different things: a capacity, and a product of the exercise of that capacity. Language in the former sense—that is, a power to express thought by means of signs, and to develop this instrumentality into a great and intricate and wonderful institution, having the most important bearings on the progress of the individual and of the race—is a gift, a quality, a part of human nature, and all that; but this power does not give a single human being *his* language: it does not issue in any thing except through an historical development, by a gradual accumulation of the results of its exercise. It makes every human being capable of learning and using any language. It implies also that every human being is capable of producing a language—only let circumstances be sufficiently favorable, and give him time enough: say a few hundreds or thousands of ordinary lives. But the English language, for instance, or any other, is not such a capacity: it is the concrete accumulated product of the efforts at expression of the English-speaking or other community and its ancestors, continued through thousands of years. Each such product has its history: that is to say, it has been wrought only in time, and under the infinitely varied modifying influence of historical circumstances; each is different, therefore, from all the rest: a thousand different products, of every degree of diversity, but each one answering the same general purpose, and capable of being acquired and wielded by every normally constituted human being, of whatever race.

An additional obstacle, of another character, is the (of course, unconscious) craving of many people after lofty and poetic general views, views of which the very conception shall seem to exalt them. The doctrines set forth above are in many respects iconoclastic, and therefore repellent to them. They want to regard man's acquisitions as direct gifts to him from his Maker, or as spontaneous outbursts of his noble nature. M. Renan says ("Origine du Langage," chap. iii.), "Languages have come forth completely formed from the very mould of the human spirit, like Minerva from the head of Jupiter." Precisely so, we might answer; the comparison has a more complete applicability than even the eloquent author imagined; the one thing has the same kind of truth as the other; each is a beautiful myth, and it is hard to see why he who seriously accepted the former should not accept the latter also. For one man, we have taken all the poetry out of life when we have made him see that it is not his God, rolling on mighty chariots through the sky, and hurling thunder-bolts at the demons, but mere prosaic meteorological forces, that cause the thunder-storm; we have perhaps robbed another of both religion and self-

respect when we show him the earth gradually cooling and condensing, clothing itself with vegetable and animal life; and man himself creeping up through the ages from a condition of savagery, gradually finding out his powers by their exercise, laying up and shaping institutions—language among the rest—for traditional transmission, the knowledge and wisdom which are one day to raise him to the headship of Nature. We are all loath to put a truth regarded as humble in place of a brilliant error; and slow to realize that, when the false coloring is taken off, what remains is worth more to us than what we thought we had before.

There is, it is believed, a wide-spread impression that views of language of the kind advocated in this paper are "superficial;" and that only those treat the subject profoundly who lift it up either into the sphere of psychology, or on to the platform of the physical sciences, making linguistic study a department of the study of mind, or else of that of human organs and their functions. But that is a matter to be settled along with the truth or error of the views in question. If they are true, then those are superficial who, in a mistaken endeavor after profundity, abandon the true basis and method of their science. There are infinite mysteries involved in every act of language-making and language-using, with which the linguistic scholar, as such, has to do only secondarily, or not at all. To recur to our former example: the psychological processes whereby the rude conception of a *book* is formed, partly under instruction, and gradually developed into fullness and accuracy, are one subject of study; the physiological processes whereby one hears the word *book*, and then is able to reproduce it, by an imitative effort of his own organs, is another; the history of the civilization which has given birth to such product, and of the arts by which it is manufactured, is yet another; and there are more, clustering about the same word: with the great problems of existence and human destiny looming up in the background, as they do behind every thing that we attempt to investigate. But no one of these is the standing-point of the linguist; to him, the central fact is that there exists one audible sign *book*, representing in a certain community a certain conception, for all purposes of communication; used by hosts of people who know nothing about the history of books, nor about the operations of the organs of speech, nor about the analysis of mental processes—and answering their purposes as well as if they knew it all. The sign had a certain definite time, locality, and occasion of origin; it was applied to its purpose for reasons which lay neither in men's mental nor in their physical nature, but in their historical conditions; it has passed through certain changes of form and office on its way to our use. Here, now, is where the linguist takes his stand; from this point of view every thing falls into its true position of relative prominence. Language is a body, not of thoughts, nor of physical acts, but of physically apprehensible signs for thought; and the student of lan-

guage begins his work upon the signs, their office, and their history. Between him and the students of the other branches named there is a relation of mutual helpfulness. The history of words and the history of things cast constant and valued light upon one another. The sounds of language illustrate the articulate capacity of the organs of utterance, and their changes require for explanation a knowledge of phonetic science, as a special department of physiology and acoustics combined. And the contributions of language to psychology greatly outweigh in value those of psychology to the science of language, since the latter is the key to the historical development of human thought; and since words are not the immediate product of processes of cognition, or abstraction, or induction, but only the result of voluntary attempts to communicate those products. Most students of language, probably, believe all this, and act in their studies upon the belief; only they are too uncertain of their ground not to be often driven from it by the imposing claims of outsiders.

About eight years ago (in the autumn of 1867), I put forth a connected and carefully-reasoned exhibition of my linguistic views, in a volume entitled "Language, and the Study of Language;" in it I dealt only sparingly in controversial discussions of others' opinions, but left my own to recommend themselves by their concinnity, their accordance with familiar facts, and their power to solve the various problems which the science presents. Of the reception accorded to that volume I have no right to complain, and certainly I never have complained. But I have, at about that time and since, repeatedly taken occasion to examine narrowly and criticise freely the opposing views of others, and the arguments by which these were supported. And I have done it especially in the case of men of eminence and celebrity, men to whom the public are accustomed to look for guidance on this class of subjects. This, surely, was neither unnatural nor improper. What Smith, Brown, and Robinson, may say about language before ears that heed them not, is of the smallest consequence; but if Schleicher and Steinthal, Renan and Müller, are teaching what appears to me to be error, and sustaining it by untenable arguments, I am not only authorized, but called upon, to refute them, if I can. The last of the gentlemen just named, however, in his paper in the *Contemporary Review* for January last (p. 312, *et seq.*), even while very flatteringly intimating that my habit of criticising only the most worthy of notice is appreciated, and hence that those criticised feel in a certain way complimented by it, appears to think that their greatness ought to shield them from such attacks. I have very little fear that the general opinion of scholars will sustain him in this position. Each controversy is to be judged, rather, on its own intrinsic merits. If I have failed to make out a tolerable case against those whom I have criticised, then, be they great men or small, I have been guilty of presumption, and deserve reproof; if, on the contrary,

I have fairly sustained my views against theirs, I am justified; and on that basis I am perfectly willing to submit to judgment.

I do not think Prof. Müller the person best qualified to judge me fairly, because, in the first place, owing to his great fertility as a writer, and his position as accepted guide and philosopher, beyond any other living man, of the English-speaking people, I have felt called upon to controvert his views oftener than those of any other authority; and yet more, in the second place, because he does not appear to have qualified himself by carefully examining what I have written. He confesses to never having looked at my volume on language until a few weeks ago, when stirred up to it by the fact that my opinions had been quoted with approval in so conspicuous a quarter as the pages of the *Contemporary*. And, even now, he has evidently given it the most cursory examination. He has not observed that it was printed and published in England, instead of "in America." He has not discovered that it is a "systematic" discussion of its subject. He is mainly impressed, even to amusement, with its similarity to his own work: as, indeed, resemblances at first glance are always more striking than differences: if he will continue his study, he will certainly find the likeness less and less apparent, and extending almost only to those facts and principles which are universal property among philologists, neither he nor I having a patent-right to them; while the underlying differences of view and plan will become more and more conspicuous to him. And, most of all, he picks out and sets forth certain alleged inconsistencies in a manner which only great haste can explain and excuse, since every one of them would be removed by a consideration of the place and connection of each passage quoted. He is even more than once so unlucky as to select a passage as showing me to hold a certain view right out of an argument in favor of the contrary view. For example (p. 310), in citing my expression that the facts of language "are almost as little the work of man as is the form of his skull," he overlooks the preceding clauses of the same sentence: "So far as concerns the purposes for which he [the linguistic scholar] studies them, and the results he would derive from them." The whole being a part of a statement intended to show that "the absence of reflection and conscious intent takes away from the facts of language the subjective character that would otherwise *belong to them as products of voluntary action.*" There are several other cases quite as palpable as this: it is useless to expose them here.

I ought to be more than satisfied with the insignificant array of trifling errors (or supposed errors) of detail in my volume, drawn up by Prof. Müller on page 312; unfortunately, I could myself, if called upon, furnish a much heavier list. I only notice one, as being an important evidence of the haste and cursoriness already referred to. My critic is shocked to find "the Phœnician alphabet still spoken of as

the *ultimate* source of the world's alphabets." Ultimate it certainly is, in the sense of being that alphabet from which the others derive themselves, in part through many intermediaries; the point in which they all centre: but if Mr. Müller had looked at the twelfth lecture, in which the Phœnician mode of writing is made the subject of more than a mere passing remark, he would have found its own derivative character most explicitly asserted and supported.

If Prof. Müller has not been willing to read until just now the work in which I had independently and connectedly put forth my own system of views, he has not, of course, been in a position to estimate fairly the critical articles in which I have had the avowed polemical intention of trying whether they could stand their ground and make head against the opposing views of other writers. It might naturally enough seem to him that I was too pugnacious. But I cannot help questioning whether he has ever read those articles also, or knows them in any other way than as he knows the one recently used in the pages of the *Contemporary* by Mr. Darwin: namely, in fragments and by the report of others. I am confident that he would not otherwise so misconceive their spirit, imagining that I am in the habit of making general depreciatory remarks about the scholars whose works I examine, and of casting hard words at them in place of arguments. He cites a little list of such words, which have caught his eye as he turned over my pages, and which he has conceived to be applied to himself. I cannot help quoting a passage in which—and, so far as I know, in which alone—two or three of them actually occur. After explaining my own views as to the origin of language at some length, I add (p. 434): "The view of language and of its origin which has been here set forth will, as I well know, be denounced by many as a low view: but the condemnation need not give us much concern. It is desirable to aim low, if thereby one hits the mark; better humble and true than *high-flown*, *pretentious*, and *false*." The words here underscored are those complained of by Prof. Müller: if they are applied to him, or to any one else, it must be by himself, not by me. Those to whom my works are really known will, I am sure, defend me against Mr. Müller's unfortunate misapprehension. I do not judge men, but views, and especially the arguments by which views are upheld. If I deem the latter insufficient or erroneous, I confess that I am apt to speak my mind about them too plainly. If one finds a whole argument founded on the assumption that two and two are five, it is, of course, the true way to say that "Sir Isaac Newton would not have reasoned thus; and, on the whole, it is safer for us to agree with Sir Isaac," rather than to declare the assumption false, and every thing built upon it unsound: yet, after all, if the latter is really true, and if the occasion for bringing out the truth is a sufficient one, and if the critic shows good faith, a desire to arrive at the truth and to treat his opponent with substantial justice, the shorter and blunter way is not

to be too utterly condemned. And, as I have said above, I am ready to be strictly judged by the truth or error of my criticisms.

The plainest of plain speaking is far less really injurious than misrepresentation and detraction under the mask of extreme courtesy. Surely, so much wholesale depreciation and imputation of unworthy motives can hardly be found in all my writings as Mr. Müller raises against me in this one article. I should not venture to accuse any one of being actuated in his literary work only by personal vanity and a lust for notoriety, except after the summing up of a long array of particulars and deductions—I think not, even then. If I declared any one to be noisy about a subject in inverse proportion to his examination of it, I should at least want to refer to examples that illustrated the peculiarity. Does my critic put these accusations forward as his example of how a controversy should be conducted in a gentlemanly manner? If I stated that any one "bitterly complained" that he was not answered by those he criticised, I should feel called upon to give chapter and verse for it; and neither Mr. Müller, nor any one else, can point out any such complaints on my part. I regard this as one more evidence of Mr. Müller's careless and insufficient examination of my writings. He got his wrong impression, I imagine, from an imputation which Steinthal brings against me. I did blame Steinthal for undertaking, in his chapter on the origin of language, to report and refute the opposing views only of the last-century theorists, as if there were no more recent opinions on the subject which had a claim to be considered; and he was pleased to interpret it as a reproach to him for not mentioning myself! I should think far worse of him and of Mr. Müller than I do, if I supposed them incapable, in their cooler moments, of understanding that a man may, without any improperly selfish feeling, be astonished, and even indignant, to see the views, which he holds in company with a great many others, quietly ignored; or that he may hold them so heartily that he shall feel called upon to stand forth in their defense whenever they are unjustifiably passed over, or are assailed with what seem to him unsound arguments.

My article upon Steinthal was so different from what Mr. Müller appears to assume it to be, when speaking of that scholar as having "retaliated with the same missiles with which he had been assailed," that I can only infer that it, too, is unknown to him except by false report. In a chapter of his recent work, "Abriss der Sprachwissenschaft," Prof. Steinthal seemed to me to have piled together about as many paradoxes as could well be gotten into so small a space, pushing the psychological method to an extreme which was almost its own refutation. To pick out a few points: for a definition of language, he gives us "it is what it is becoming"—he declares the divine origin of language inadmissible, because no science, save the philosophy of religion, has any right to take account of God; he holds primeval man—in distinction from the philosophers of the last century, who

wanted to degrade him—to have been a being of "creative force, from which religious and moral ideas flowed forth unsought;" his comparisons imply that language came into fully-developed being at once; he asserts the investigation of its origin to be "nothing else than this: to acquaint ourselves with the mental culture which immediately precedes the production of language, to comprehend a state of consciousness and certain relations of the same, conditions under which language must break forth," etc.; he denies that a child learns, or can be taught, to speak; he claims speech to be a capacity and activity like seeing and hearing; and he winds up with the conclusion that there is no such thing as an origin of language, except as it originates anew in every word we utter! Such views, expressed by one who stands so high in public estimation in Germany as Steinthal does, seemed to me to demand thorough examination. In my criticism, I went through the chapter, paragraph by paragraph, quoting in the author's own words nearly half of it, as I should estimate, and discussing in detail the various points made by him. Perhaps I carried on the discussion more vehemently than was necessary or desirable; I hold myself open to all due reprehension on that score; but that there were any personalities in it I utterly deny; it was an argument throughout, if a polemical one; it addressed itself only to the opinions it opposed, and the considerations by which these were supported. After nursing his wrath for two years, Steinthal came out in reply last summer with a volley of Billingsgate, pure and simple (Mr. Müller gives, p. 313, some choice examples of it); he enters into no argument, he makes no defense—unless it may be called a defense that he seems dimly to claim that, being only engaged in a preliminary laying out of his subject, he ought to have been indulged in putting forth any thing he pleased without being called to account for it—he tears his hair and splits into two persons with rage and disdain, and calls his assailant a villain and a fool. To such a tirade, there is but one answer possible; and to that I have no disposition to resort. Any one may judge from the specimens of Steinthal's views given above, whether they are so obscure from profundity that a man of less than extraordinary penetration cannot hope to understand them; *to me*, the only incomprehensible thing is, how a man of learning and acuteness should have arrived at them, and should have so little to say for them. I am perfectly willing to lay the *acta* of the controversy before the public just as they are—Steinthal's chapter, my criticism, and his retort, without a word further added in my own defense; and I should be confident of a general verdict in my favor.

Prof. Müller fears that I am generally becoming convinced that I am unanswerable. Perhaps every one runs that risk who, after what seems to him due examination and deliberation, has come to hold a certain set of opinions with great confidence, and who, with his best endeavors, does not find among opposing views and arguments any

that can overbear his own. One thing I am certain about: namely, that neither Müller nor Steinthal has answered me. As Mr. Müller appreciates so fully the danger in which I am placed, I wonder that he is not willing to put forth a hand to save me from it. I have with these gentlemen, so far as concerns my side, only a scientific controversy, sustaining my view of language against their contrary (and mutually conflicting) opinions. If I have been over-warm in assault, that is my disadvantage as well as my fault, as I thereby lay myself the more open to a counter-attack, having no right to claim to be treated more gently. But I have a right to protest against the controversy being made a personal instead of a scientific one; against being met with the plea that I am too disrespectful to the magnates of science for my arguments to deserve attention. Such a reply is generally, and justly, regarded as equivalent to a confession of weakness.

It has, perhaps, been my misfortune not to appreciate sufficiently the services rendered by Prof. Müller to the science of language; certainly, while fully acknowledging what he has done toward spreading a degree of knowledge of its facts, and, by his *prestige* and eloquence, attracting to them the attention of many who might have been reached in no other way, I might have been able to see that he helped either to broaden its foundations or to strengthen its superstructure. In ways and for reasons which I have sufficiently detailed in other places, his views have seemed to me wanting in solidity of basis, and in consistency and logical coherence. The difference between us is by no means of that slight character which, in his article, he gives it the air of being—"a slight matter of terminology," and the like; it reaches to the bottom. Holding as I do, I cannot expect that his proposed work on "Language as the True Barrier between Man and Beast," whatever its general interest and readableness, will be a contribution of serious importance to the discussion of the subject. Nor, indeed, that, by any one, more can be made of this barrier than has been made of the various others, which a profounder zoological and anthropological science has thrown down, claiming that no impassable barrier, but only an impracticable distance, separates the two—and separates them just as effectively. If my view of the nature of language is the true one, the absence of speech in the lower animals is easily seen to be correlated with many other deficiencies incident to their inferiority of endowment; they have no civilization, no "institutions" of any kind; nothing that goes down by tradition, is taught and learned. Their means of communication is almost wholly intuitive, not arbitrary and conventional, which are the most essential and highest attributes of ours. I say "almost," because I think the want not absolute; the rudiments of speech are just as much present in animals as, for example, those of the use of instruments; on account of which latter, Mr. Müller pronounces the "use of tools" no barrier.

Human language began when sign-making by instinct became sign-

making by intention; when, for example, an utterance of pain or pleasure, formerly forced out by immediate emotion, was repeated imitatively, no longer as a mere instinctive cry, but for the purpose of intimating to another, "I am (was, or shall be) suffering or glad;" when an angry growl, once the direct expression of passion, was reproduced to signify disapprobation or threatening, and so on; that is to say, when expression for personal relief was turned into expression for communication. The human intellect had the power to see what was gained by this means and to try it further; and it could follow on and on, in the same course, until a whole language of signs was the result. It cannot be successfully maintained that no animals are capable of taking even the earliest steps in this process; if a dog stands outside a door, and barks or scratches, to attract attention, and then waits for some one to come and let him in, that is, in all essential respects, an act of language-making; and the dog, and some other animals, can do much more than that. Here is the point to which the attention of naturalists should be directed, if they wish to determine how far the animals advance on the road to language; to what extent are they able to turn signs—utterance, or gesture, or posture, or grimace—to account for the purpose, and with the intention, of intimating meaning. To determine what definite natural cries they have is comparatively nothing to the purpose, since these are not the analogue of human speech; to put the inquiry on this ground, involves the capital error of attributing to the human voice a special relation to the apparatus of mental action, as its natural means of expression, instead of regarding utterance as merely that form of bodily activity which, on the whole, is most available for expression, and which, therefore, after due experience of its advantages, is most availed of by man. The real expressiveness of cries and exclamations lies, not in their articulate elements, their vowels and consonants (if they have any), but in their tones; and we keep these same tones as auxiliaries of the very highest value to our articulate speech, when we wish to impress and persuade.

Quite as much, I am sure, lies within the compass of the lower animals, in the way of intentional intimation of their wishes, as in the way of tool-using; and hence the former is no more a "barrier" than the latter. But the animals can go no further in the direction of developing their rude beginnings of expression into a language, than of working up their tools into a mechanical art, with all its appliances, simply because they have not the capacity; and in this capacity of indefinite development, by accumulating the results of the exercise of his powers out of a condition originally as low, or wellnigh as low, as that of the animals, lies the distinction of man—a distinction which ought to satisfy the most exacting lover of his species.

As regards "general ideas," of which Mr. Müller arrogates to himself and his followers the monopoly, I confess to being wholly of the opinion of Mr. Ellis: "Animals, to my mind, have concepts, with quite

as much right to be termed general, as any which I possess myself, the difference being one of degree." So long as Mr. Müller puts his exclusive claim solely on the ground that animals have no language, he must not expect to gain over many adherents. "Animals cannot talk, because they have no general ideas; they evidently have no general ideas, because they do not talk"—surely, as pretty a circle as ever was drawn with compasses; a mere duplication and bending around into a curved and reëntering form of the dogma that thought is impossible without words; that the intellect cannot apprehend resemblances and differences, cannot compare and infer, without the bodily organs to make signs for it. If this is an exaltation of the value of language, it is an equal degradation of the power of the mind.—*Contemporary Review.*

## THE CONSERVATIVE DESIGN OF ORGANIC DISEASE.

By Prof. A. F. A. KING, M. D.

IF we should say that diseases prolong life, that without them man would be more liable than he is to sudden death, the announcement would be received by most medical thinkers, and by all those who have never studied pathology at all, as a transcendental idea, quite insusceptible of logical proof. But it is otherwise: that certain processes of disease are really conservative, and contribute to the longevity of the individual, is an absolute fact, as we shall now endeavor to demonstrate.

Let it be noted that almost from time immemorial physicians have recognized in the body a certain power of resisting injuries, and of returning spontaneously to health, when disordered; and this they have called the power of Nature—the *vis medicatrix naturæ*. The growth of this idea culminated, during the sixteenth century, in the establishment of the so-called "Stahlian system of medicine." And, while the doctrines of Stahl were sustained and elaborated by many of the leading physicians of his day,[1] we now know they were erroneous, for he maintained that there resided in the organism a "*rational soul*" which, he affirmed, not only formed the body, but excited and directed all of its motions; it was alleged to perceive intelligently the tendency of all external impressions acting upon the body, and to excite such motions as would favor the beneficial and obviate the injurious influence of such impressions. Hence, generally speaking, diseases were considered to be salutary efforts of the "presiding soul," and were to be

[1] By Perrault in France, Gaubius in Holland, Porterfield and Simpson in Scotland, Juncker in Germany, and by Nichols and Mead in England.

assisted, and not interrupted, by the interference of art; it was, however, admitted that the "rational soul," owing to surprise, fear, or despair, occasioned by too sudden or vehement impressions made upon it, would sometimes excite adverse motions which it was right to moderate.

Prevailing only for a season, the system of Stahl was finally abandoned as a visionary hypothesis; it was deprecated, as leading physicians to neglect the use of remedies; for its followers, trusting chiefly to the attention and wisdom of Nature, adopted the inactive mode of curing by expectation—*la médecine expectante*, as the French term it. The use of opium, cinchona, mercury, and other potent medicines, was zealously opposed by the Stahlian physicians, and they were extremely reserved also in the use of bleeding, emetics, and other evacuant remedies.[1]

Before we dismiss this part of the subject, it may be worth while to note, as illustrating the not uncommon cyclical revolution of opinion on scientific questions that are yet unsettled, that the medical practitioners of to-day—at least the best or most successful of them—have adopted the identical mode of practice for promoting which the doctrine of Stahl was allowed to fall into disrepute. Nowadays, like the Stahlians of old, we have laid aside bleeding and emetics, mercury and evacuants, and, content with feeding the patient and contributing to his comfort, we leave the disease to take care of itself—we trust again to the *vis medicatrix naturæ*. The physician of to-day who should boast of *curing* a disease (unless, indeed, it were an ague, with quinine), would be considered, by his more highly-informed fellow-practitioners, as profoundly ignorant of the recent advances made in the science of pathology.

Another erroneous hypothesis, not differing very widely from the idea of Stahl, and which may be named and dismissed before we proceed, is that which supposes the existence, in the nervous system, of some tangible, central point of nerve-matter, from which, as from a seat of government, mandates are issued to control the motions and changes that take place in every quarter of the organism; and which leads us to infer that processes of disease, since, as it would seem, they are allowed to take place by this governing "central point," would be rather protective than suicidal to the individual. This view—never very widely acknowledged—received its final death-blow by the publication of Virchow's "Cellular Pathology," in which it was shown that the entire organism, in all its parts, is really composed of an indefinite number of individual centres, in fact cells, each of which has a life of its own, performs its own functions, and dies its own death: it is the invisible motions of these millions of microscopic entities,

[1] Stahl's principal work, in which his system was displayed in its most matured form, was entitled "Theoria Medica vera, Physiologiam et Pathologiam sistens." Printed at Halle, in 1708.

which, in the aggregate, constitute the visible changes and actions which we say characterize life. The anatomist has never discovered any "central point," nor the microscopist any "single cell," which governs the motions of the rest. Every supposed "central point" has been found, on microscopic examination, to split up into innumerable millions of centres, or individual cells. Moreover, in plants, in which the processes of life appear to be directed quite as intelligently as they do in animals, no trace of a nervous system has yet been demonstrated.

To many of my readers it would perhaps be a much more acceptable explanation of the (what seem to be) *intelligently*-directed processes going on in living bodies, than either of those already mentioned, to say that they must be ascribed to the rational will of a Creator urging an unconscious organism, by the laws he has ordained, to perform certain acts necessary to its preservation.

But, as the absolute scientists and those who religiously believe in a Creator are just now crossing swords, I will not press this third explanation, but rather choose to sustain the position I have assumed on the broader middle ground of natural philosophy.

To return, therefore, to the main proposition, namely, that organic diseases are naturally designed for, and do in fact accomplish, the prolongation of life, it will be observed that I have purposely omitted from consideration those other and more simple kinds of derangement which we call *functional diseases*. The conservative use of many of these latter has been universally recognized. The vomiting that occurs when poisons or indigestible matters have been introduced into the stomach, does good, by removing the offending substances. In like manner, the functional derangement of cough secures the expulsion of irritating gases or powders that have been inhaled, and of the accumulations of mucus that occur in every bronchial catarrh, and which would otherwise clog the tubes and induce suffocation. The watery diarrhœas that arise from indigestible articles having passed into the intestine, cure themselves by washing away the irritating materials, and the intelligent physician, instead of curbing the derangement, assists it with a laxative, and so helps Nature with the cure.

When, however, we come to speak of the more permanent *structural* changes, which neither Nature nor art can remove, and which have seemed to produce premature death, scarcely any one will acknowledge that the processes which develop them are at all conservative. Yet they are. And the error of supposing they are not has arisen chiefly from a total misunderstanding as to the *nature of disease*. A very prevalent idea, if not indeed a universal one, seems to be, that disease is a separately-existing entity—a thing independent of the body and inimical to it. We constantly hear, for example, of an individual being "attacked" with pneumonia; of an army "as-

sailed" with small-pox; of a city "assaulted" with cholera, and of its inhabitants being decimated by the "stealthy ravages" of consumption. Now, *so considered*, there is no such thing as disease. Who has ever seen it isolated from the body?—And when, in accordance with this view, we ask the question, "What *is* disease?" there is but one answer, namely: Disease is the tertiary product of two factors: 1. Of impressions or stimuli acting upon the body from without; and, 2. Of the reactions performed by the organism in response to the impression of such stimuli. The *tertium quid* following the action without, and the reaction within, is the thing "disease." Exactly in the same manner a stone thrown against a pane of glass makes a hole in it; yet, when we try to consider the hole as a separately-existing entity, we find it does not so exist. If it did, we might take away the pane of glass, and leave the hole by itself, but this is impossible. The aperture in the glass is a *tertium quid* resulting from two factors. viz., 1. The action of the stone from without; and, 2. The reaction of the glass when struck by the projected missile. Furthermore, it is evident that the *quality* of the resulting tertiary product can be made to vary indefinitely, either by varying the character of the action (i. e., by modifying the shape, size, direction, velocity, etc., of the stone), or by altering the reactive properties of the glass (i. e., by modifying its thickness, elasticity, inclination, etc.). Equally so the quality of disease will vary in different individuals in accordance with the variation in the quality of their reactive powers, as well as in conformity with the character of the actions by which the reactions are elicited.

Now, since the external stimuli which act upon the body in the manner we have described only produce their effect in *living organisms* (for in dead bodies and inorganic matter they do not elicit similar reactions), it is evident that the tertiary products which we call organic disease are purely the result of *vital processes*, and for this reason alone must be conservative, as are all the phenomena of life. Once dispute this and we should have to adopt the other alternative, that the organism would be better off if the reactive powers with which we find it to be endowed were annulled; and this conclusion would compel us to acknowledge the possibility of our thinking out an *improvement upon Nature*—a monstrous assumption, which no student of science will for a moment entertain.

In a condition of health the various processes going on in the body, which we call vital phenomena, are nothing more than a series of internal reactions provoked and maintained in obedience to the impression of surrounding conditions that act upon the organism from without. The reactive powers possessed by the healthy organism are perfectly natural to it, and, so long as the external stimuli impressing the body from without are also perfectly natural, the resulting *tertium quid* will simply consist of a naturally-constructed, a physiologically-developed organism. And if we now ask ourselves, "What is the use or design

of organs and structures that have thus followed a perfectly normal course?" we are soon able to discover that there exists between the developed organs and the external stimuli which provoked their development a mutual relation of such a kind that one is perfectly adapted to the other; in a perfectly natural state, physiological organisms are nicely adjusted to the external conditions surrounding them, in which it is natural for them to live, and which require of the organs developed just such functions as their formation and power adapt them to perform. *Adaptation of the organism to its environment* is, therefore, the grand purpose of the peculiarities of structure observed in different animals and plants. It is almost needless to present illustrations; they occur without number, and are quite apparent to the most superficial observer. The digestive organs are differently constructed in the herbivorous and carnivorous animals, and are thereby adapted to the different kinds of food on which the animals subsist. The gills of fish and the lungs of mammalian quadrupeds are structurally and functionally unlike; the differences adapting the breathing-apparatus of each animal to the particular kind of respiratory medium in which it is to live. And so of all other organs.

Now, if, instead of permitting the organism to remain living in its natural state, we change the surrounding natural conditions to others that are unnatural, the action of these latter will excite in the organism corresponding unnatural *re*actions: at first an unnatural modification of *function* will ensue; and in time, if the modified functions are in this manner continued, we observe a corresponding modification of *structure* to follow. But the modifications of structure, thus induced, are nothing else than *organic diseases;* they are departures from the physiological standard of health. And if we ask, "What is the conservative use and designed purpose of these unnatural deviations?" the answer is, that *the modifications of structure adapt the affected organs to modified functions that they have been called upon to perform, and mould the organism to new conditions that have been brought to act upon it;* just as variation in the physiological construction of different animals adapts them to the various differences of surrounding media in which they are designed to live. Pathology, therefore, is really nothing else than modified physiology. Physiological development is the evolution of organs and the growth of organisms under the impression of *natural* external conditions; pathological development is the evolution of organs and the growth of organisms under the impression of *un*natural external conditions. Adaptation of structure to function—of organisms to surrounding media—is the designed conservative purpose of both kinds of growth.

Furthermore, as no two human organisms are ever, in any particular, precisely similar, and as between organisms that have followed a strictly physiological development, and those whose development has been decidedly pathological, there are still others of intermediate

character, whose deviation from physiological and approach to pathological development have been less decided, or extremely slight, it is evident there exists between the two kinds of growths no well-defined line of demarkation; physiology and pathology run gradually into each other. It is not possible to say where one ends and the other begins. That this must be the true state of the case is unmistakable when we consider that the change of external conditions from natural to unnatural may be in any—the slightest or the most extreme—degree. Thus we frequently observe modifications of structure induced by exceptional conditions that have been brought to act upon the body, of so trivial a character that they can hardly be called diseases, while at the same time they are in some measure anomalous deviations from the typical standard of the species; but in these, as in the higher grades of structural modification, it will be seen that the conservative purpose of adaptation is carried out. For example, the muscles in the right arm of the blacksmith, those of the leg-calf in the limbs of the dancer, and the crural adductors of the jockey, undergo a process of increased growth (a physiological hypertrophy) by which they become adapted to the increase of function imposed on them. So the thickened epidermis of a laborer's palm adapts the hand—by protecting the softer tissues underneath from being bruised—to the rough handling of manual instruments; an adaptation altogether wanting in one unaccustomed to labor, as evidenced by the inflamed and blistered condition of his hands when first beginning to practise such exercises.[1] By the same kind of thickening and induration the finger-ends of the violinist become adapted to sustain without inconvenience prolonged pressure upon the strings of his instrument. When the main artery of a limb has been obstructed, or tied by the surgeon's ligature, we find the nutrition of the tissues beyond is supported by the blood finding its way through the smaller anastomosing arteries, and in time we observe these smaller arterial branches to become considerably enlarged, thus adapting themselves to the increased amount of blood they have been called upon to transmit. In cases where obstruction to the arterial circulation is more general, so that it requires an increased heart-force to pump the blood through its channels, we observe the heart itself to become larger, and thus its increase of structure (like the blacksmith's arm) is adapted to the required increase of function. The head of the thigh-bone, when irreducibly dislocated, becomes surrounded in its new position with fibro-ligamentous and muscular structures, which so far resemble an articulation as to permit the patient to walk about. Similarly in ununited fractures, we find the ends of the broken bone, when the muscles attached to them cause

[1] If it should here be alleged that the "inflammation" is the real disease, and that it accomplishes no good, we answer: Inflammation is the process by which the mechanical injury of contusion is to be repaired. It restores the part, just as the "adhesive inflammation" of surgeons heals up the cut of an incised wound.

the fragments to move one against the other, become covered with cartilage and encapsulated with fibrous and ligamentous tissues, so as to form the "false joint" of surgeons. Mucous membranes, when continuously exposed to the air, adapt themselves to their new situation by becoming covered with a layer of epidermis closely resembling skin. Of this we have a good illustration in long-standing cases of *procidentia uteri*, where the vaginal mucous membrane is often continuously exposed.

The vegetable world also furnishes numerous illustrations showing how plants adapt themselves, by modification of structure, to new conditions in which they have been placed. The geranium in our window, instead of growing in its naturally vertical direction, disposes its twigs and branches obliquely on one side, thereby adapting them, their leaves, blossoms, etc., the better to receive the rays of light that come in slanting through the window. Plants kept more or less in the dark, have a deficiency of color; they become bleached and white, but this lessened opacity of their skin, this increased transparency of tissue, enables them to make the most of what little sunshine is allotted them.

The sprouts of an onion or potato, when kept in a dark chamber, grow to an *unusual length*, and, although this elongation can accomplish no good when the bulb is packed in a barrel, or housed in a cellar, still it is evident that the plant is obeying the same laws of adaptive growth by which, when buried deeply in the earth, its sprouts increase in length until they reach the sunny surface of the soil.

Now, while these instances (and many others might be added) certainly furnish unequivocal evidence of a disposition on the part of organs and organisms to adapt themselves to new conditions in which they have been placed, and to altered functions they have been required to execute, yet it must be admitted they exhibit little or no proof that those other organic alterations, which we regard as fatal diseases, are imbued with the same conservative design. In fact, to meet the issue at once—to strangle the serpent before we take out his fangs—it is necessary to dispose of the objection that organic diseases, structural formations resulting from pathological development, produce physical pain, and lead to death; for that they do so is the common belief.

To meet this objection it is simply required to follow out the analogy, already alleged, between structures resulting from *physiological development* and those produced by *development that is pathological*. That the *causes* and *objects* of the two kinds of growths are the same, has been previously intimated. We proceed by calling attention to (what may surprise those who have not given the subject proper consideration) *the great fatality attending physiological evolution:*

Very young animals, and indeed young plants, are peculiarly liable to die before reaching maturity. This is especially the case in animals,

at least during the first few days of life, but the liability continues, though in a gradually-decreasing ratio, until physiological development is complete. Breeders of stock know very well the difficulty of rearing the young; and even in wild animals that live in a perfectly natural state, untrammeled by domestication, a good proportion of new-born individuals perish in early life. Gardeners and agriculturists drop more seeds in a place (of corn "in a hill," for instance) than they intend shall remain as plants, knowing that in the earlier stages of growth many of the "seedlings" will die; and, if more shall remain than is advisable, they are afterward "thinned" by hand. Surely every mother of a family knows the difficulty of rearing children, and our "bills of mortality" sufficiently attest the immense *fatality attending physiological development in the human family.*

Now, while in each of the instances I have cited the causes and mode of death are similar to or at least analogous with each other, it is only in the case of our own species that, generally speaking, we say death has been caused *by disease.* In the young chick, the wild animal, and the seedling plant, we are content to say they die because they are young, or "tender." The truth is, that death has been due, in each case, to *an arrest of, or interference with, the quite normal process of physiological development,* and to put this conception to a further test we may begin still a little earlier in life by studying embryonic development. In the case of oviparous animals, for example, we know many of the eggs never come to perfection; the young embryos they contain die during incubation. And while the pathologist, if he were to delve with his microscope into the secret physiology and pathology of the growing embryo, might find different membranes and organs fatally affected (congested or inflamed) according to the different stages of development at which the mortal disturbance took place, it would seem very odd, in case it should happen to be the rudimentary lungs of the growing embryo that were found specially congested, if he should say the egg had been "attacked" with pneumonia (inflammation of the lungs); or, if he should find the heart or intestines congested, how queer it would sound to say the egg had died from an attack of carditis (inflammation of the heart), or enteritis (inflammation of the intestines)! yet these so-called diseases are just as much causes of death in the egg as in the child after it is born.

The relevancy of the facts mentioned to the question at issue—the bearing of the argument—is this: organisms undergoing physiological evolution, and those in which pathological evolution is going on, are alike liable to be fatally affected by certain disturbing causes that interfere with the typical progress of development in each; hence the great mortality incident to childhood and early life is strictly analogous with the mortality attending organic diseases in the adult.

This analogy may now be further sustained by considering what these disturbing causes really are; and here I may premise they will

be found to be the same both in physiological and pathological development.

Most prominent among the conditions necessary to secure the normal progress of physiological development is *warmth;* and nothing more decidely interferes with it, or more quickly arrests it, than exposure to *cold.* In fact, an elevated temperature is the initial power —the first mover of the developmental process in all organisms, vegetable as well as animal. It is solar heat that forces the seed to germinate, the plant to bud, and the flower to bloom. Without warmth the fecundated egg of the oviparous animal would ever remain an inert mass; hence the snake deposits her germs in a dunghill of rotting vegetable matter where they may be warmed by the heat of fermentation. The ostrich intrusts her egg almost entirely to the sun-baked sand of the African desert; and birds in general incubate for days or weeks to supply the necessary heat for securing the development of their eggs. Fish inhabiting waters that are deep and cold, seek shallower and warmer streams in which to deposit their spawn. The difference between the warm and the cold seasons of the year, as regards the prevalence of reproduction, in both animals and plants, is familiar to every one.

But, besides heat being the *primum mobile* of normal evolution, it is equally necessary to maintain it when already begun. Exposure to cold is fatal. The shivering of young animals—their great liability to become chilled on exposure to a depressed temperature—has been observed by every one; and in the breeding of domestic animals, as in the cultivation of plants, there is probably no more potent source of mortality than insufficient warmth; and, further, this mortality is found to be more prevalent during unusually cold seasons. Now, the young of our own species form no exception to this rule; they, too, are liable to suffer a fatal arrest of physiological development on being exposed to cold. Thus, in a statistical inquiry as to the average number of deaths at different seasons, and at different ages, from a table prepared by M. Quetelet, of Brussels, it appears that, during the first month of infant life, the external temperature has a very marked influence; for the average mortality during each of the three summer months being 80, that of January is nearly 140, and the average of February and March 125. This is confirmed by the result obtained by MM. Villermé and Milne-Edwards in their researches on the mortality of the children conveyed to the foundling hospitals in the different towns in France; for they not only ascertained that the mortality is much the greatest during the first three months in the year, but also that it varies in different parts of the kingdom according to the relative *severity of the winter.*[1]

Additional proof of the disastrous influence of cold in early life, and, by-the-way, an explanation of the apparent natural defect in grow-

[1] *See* Carpenter's "Human Physiology," American edition of 1856, pp. 419, 420.

ing organisms implied by the existence of a liability to be fatally injured by it, may be found in the fact that Nature has amply provided for maintaining all very young animals at an elevated temperature, and protecting them from external cold. Note, first, how animals usually breed during the seasons of spring and summer; and observe, further, how the bird feathers her nest for the reception of her young, and shelters them under her wings, at the same time imparting heat by the contact of her own warm body. Rabbits and other animals tear off the fur from their own skins in order to provide a warm bed for the young while the parent is away in search of food. Frequently, too, animals are born in broods, or litters, especially those that are nearly nude at birth, and incapable of generating heat by exercise, and thus warmth is generated, or at least maintained, by the crowding together of a number of individuals in a small space.

Whether the liability, on the part of young animals, to be injuriously influenced by cold, is owing to their vital forces being so taken up with the process of growth as to leave a smaller surplus of vitality to resist the chemical agency of a diminished temperature, or whether it is that the lack of muscular exercise in them prevents the development of heat, we may not be able to determine; but this question is immaterial so far as the fact itself is concerned, that cold acts injuriously. It seems not improbable that the liability to be unusually affected by cold may depend upon *rapidity of organic change*. Thus those organs are most readily affected whose evolution is in most rapid progress; hence the digestive organs of the child and its pulmonary tissues are more apt to suffer from a depressed temperature than its reproductive organs; the former are undergoing rapid development, the latter are in a state of almost complete quiescence. Similarly the increased rate of tissue-change incident to violent activity of function appears to increase the susceptibility to cold; thus any one who has unusually exercised certain muscles will, after exposure, find those muscles become painful, "stiff," tender, and inflamed, while the remaining muscles of the body will have escaped any such manifestations. Buds that have withstood the severest cold of winter are often killed by the late but more moderate frosts of spring, because at this latter period they are in a state of more rapid tissue-change. The egg of the fowl will bear a considerable degree of cold without losing its vitality so long as its evolutionary processes are at a stand-still; but, when the rapid changes of structure incident to embryonic development have been set up, exposure even to the ordinary atmospheric temperature of spring and summer, if at all prolonged, is sufficient to destroy its life.

The greatest security against injury, therefore, from exposure to cold, would seem to be (comparative) *structural stability—organic rest.* But, in whatever manner to be explained, the fact remains that processes of physiological development may be disastrously embarrassed

by the want of a continuous sufficiently elevated temperature, and fatally injured by direct exposure to cold.

It now remains to show that organs undergoing *pathological* evolution (conservative structural modification) are affected exactly in the same manner by exposure to cold. Speaking, first, theoretically, we find organs thus circumstanced are the seat of an exalted rate of tissue-transformation, of a change additional to that which belongs to the ordinary process of waste and repair, and therefore we should *a priori* expect to find in them the same liability to inflammation, on exposure, as was observed in organs being rapidly developed physiologically. Speaking practically, we find, *a fortiori*, that this is actually the case. What is more common, with a patient who is the subject of some chronic organic disease, than to be suddenly cut off by the occurrence of acute inflammation in the affected organ after exposure to cold? Every medical practitioner can answer. In remarking upon the influence of cold as a cause of mortality, Dr. Carpenter, in his "Human Physiology,"[1] refers to the Report of the Registrar-General for March, 1855, in which it appears that the rate of mortality, not only in infants and aged persons, but also in those affected with chronic disease, increases during the winter months, and diminishes in summer. The deaths in many instances (in old persons) were due to pneumonia, bronchitis, asthma, and various chronic diseases; so that Dr. Carpenter is led to observe that "cold brings quickly to a fatal termination many maladies which it does not directly induce." Nay, the acute inflammatory attack, under such circumstances, is often enough the first intimation, to the patient, and perhaps to the physician, of the existence of organic change in the affected organ. A most common error, and, as far as I know, a universal one, is to date the real beginning of the disease from the acute inflammation, and ascribe any recognizable lingering symptoms to the acute attack having "lapsed into the chronic form;" when, in fact, the slow, chronic changes of structure were present only in their naturally-designed latent form,[2] long before, and were only made manifest to the patient by the disturbing action of cold.

As we have seen that, in organisms undergoing physiological development, those organs are most liable to be attacked with inflammation after exposure, whose rate of growth happens to be at the time most rapid, so in after-life it is not all the organs in the body that are liable to inflame after exposure, but only those in which pathological evolution is taking place. And this explains why it is, when several persons have been equally exposed, that one suffers from acute pneumonia, another from acute nephritis (kidney-inflammation), another from acute arthritis (joint-inflammation), while some altogether escape

[1] American edition of 1856, p. 864.

[2] That processes of pathological development *can* be latent, like physiological evolution, will be shown hereafter.

any unpleasant effect: these last were organically sound before exposure, and the same after it. In external, *visible* parts, that are the seat of injury or disease, or that have been wounded by the surgeon's knife, and which are undergoing the process of tissue-repair, we *see* redness and congestion follow exposure to cold, and often enough hear the patient not only complain of pain, but date its commencement from known exposure, and express his belief—reached as if by instinct—that "cold had settled on the part."

Again, as young animals instinctively dread cold, and as Nature provides them means for warmth, so in individuals undergoing evolution of a pathological kind, we observe a like instinctive dread of exposure, and a liability to be easily "chilled," while means of protection are also instinctively resorted to. The extra quilt at night; the heavy wrapper during the day; the thick woolen under-garments; the flannel "chest-protector;" the late fires in spring, and early ones in autumn, so necessary for the comfort of the invalid—what are they but imitations of the means supplied by Nature for the preservation of warmth in young animals undergoing physiological development?

We have further proof that organs undergoing pathological evolution are liable to be disturbed by cold in the manner referred to, and also that the existence of the evolutionary process is itself one of the conditions without which (in the absence of others) inflammation, after exposure, would not take place, in the fact that attacks of inflammation occur *repeatedly in the same organ.* Thus, to take a familiar illustration, it has been long ago observed that some people are liable to repeated attacks of inflammation of the lungs (pneumonia). Andral records a case of a patient who had fifteen attacks in eleven years; Chomel has seen ten recurrences, J. P. Frank eleven, and Rust has recorded twenty-eight attacks, in the same individual. A patient of Ziemssen's had four attacks in five years. It is also observed that, of the two lungs, the one first affected is most liable to suffer from subsequent attacks. In thirty-five cases of recurrence collected by Grisolle, the return of the disease was noted twenty-five times in the lung first affected. In the other ten, the disease changed sides (*see* Reynolds's "System of Medicine," vol. iii., p. 613).

The limits of the present paper precluding a very prolonged argument, we leave this part of the subject, hoping that what has been said is sufficient to account for the mortality of pathological processes which, we have said, are designedly conservative.

We may now further follow out the analogy between physiological and pathological evolution, by observing that *structures undergoing pathological development* (*conservative organic modification*), *like those that are being developed physiologically, manifest an intrinsic tendency, when undisturbed in their progress, to pursue a fixed, typical course to their naturally-designed termination. When permitted to*

*pursue such a typical course, the observed structural changes are exceedingly slow, and are attended with little or no physical suffering.*

Let us speak, first, of physiological evolution. And, to begin, let us ask, "How shall we know when physiological development is following its natural course, and when it is not?" There are two striking characteristics which can always here be taken as guides, viz., *slowness of organic change*, and *latency*. The physiological growth of tissue is always *gradual* in its progress, both as regards change of shape, bulk, and variation in physical properties. These go on with an insidious progression that is, for the most part, quite imperceptible to ordinary methods of observation. *Natura non facet saltem.* Abrupt changes of shape, size, etc., incident to *function*, are, of course, quite common, but these are only temporary, and quite distinct from the more stable organic changes constituting growth. Indeed, it may be taken as an invariable rule that structural changes of any considerable extent, that occur abruptly and remain permanent, are always unnatural, and are to be attributed to the action, direct or indirect, of some disturbing cause.

Secondly, we notice that the natural course of physiological development is characterized by painlessness—unconsciousness on the part of the individual that any tissue-changes at all are taking place. As the height of perfection in function, as in digestion, for example, consists in ignorance or unconsciousness of the existence of the organs performing it, so is it an invariable quality of every perfectly natural organic change that it should take place without the knowledge of the individual—I mean without any knowledge derived from unpleasant sensations. No argument is needed to support this statement; we will only add that, when physiological organic changes *are* accompanied with pain, it is always attributable to some injurious influence having caused the changes that are taking place to deviate from their natural and typical course.

A third characteristic of undisturbed physiological evolution is this: the developed organs, when their evolution is complete, and indeed during their development, present a *typical uniformity of structure;* that is to say, organisms whose development has been perfectly natural, provided they are of the same age, sex, species, etc., are alike; and the several organs of different individuals present a uniform standard of size, shape, and functional power, any slight existing differences being so inappreciable as to evade ordinary methods of observation. This uniformity of type, however, will only be observed in wild animals that have led a strictly natural life, untrammeled by domestication, such as ocean and river fish that have not been removed from their natural waters, wild birds, reptiles, insects, and the untamed mammalian animals. So exactly similar in such instances are the nutritive changes of waste and repair, growth and development, that not only are the size and shape uniformly the same,

but even the color of the exterior presents the same unvarying uniformity of shade. The spots on the leopard and on the butterfly's wing, the speckles and stripes on the reptile, the scales of the fish, the plumage of the bird, and the fur of quadrupeds, are tinted so precisely alike in different individuals of the same species, age, etc., that we find it difficult to detect the slightest variation. Any appreciable deviation from the standard type must always be attributed to the action of some unusual cause disturbing the normal course of evolution, unnumbered instances of which appear among domesticated animals, where, in fact, uniformity is the exception and variety quite common.

Now, to go back to *pathological* evolution, we find the three qualities of *graduality*, *latency*, and *uniformity of type*, to belong also to it, i. e., when it has followed its undisturbed typical course. We observe, however, that graduality—slowness of organic change—is common only to so-called *chronic* pathological changes; in *acute* organic diseases (those that we have seen destroy life) the change of tissue is rapid; hence an organ undergoing pathological modification that becomes the seat of an acute process (of an acute inflammation) can no longer be said to have followed its designed typical course, and we can no longer anticipate the same attaining of the pathological evolution to its designed conservative, typical completion. The acute disease is accompanied with fever, hence with rapid wasting and reduced assimilation of food; it leaves the whole organism reduced in vital power, and there remain behind inflammatory products which require to be removed; the normal progress of the gradual pathological development has been arrested; the vitality *of the part* has been weakened; there is set up in it a tendency to degeneration or local death. Indeed, time would fail us to enumerate all the injurious consequences, immediate and remote, general and local, that are liable to follow even a single acute inflammatory attack. No wonder, when such attacks occur more than once, or are repeated over and over again, that the pathologically developing organ fails of reaching its designed conservative termination; it need never surprise us, under such circumstances, that the final result is degeneration and death instead of preservation and repair.

In the several instances (very simple ones) of admitted conservative modifications of structure previously mentioned, we observed that *time* was an important element. The enlargement of anastomosing arteries that took place after the main vessel had been tied, did so by *slow degrees;* so did the hypertrophy of the heart that followed more general arterial obstruction; so did the transformation of mucous membrane into skin when exposed to air; and so do all conservative modifications of structure when they have been allowed to pursue, undisturbed, their designed typical course.

Secondly, when typical pathological evolution follows its designed

course, it is devoid of symptoms, *latent;* the tissue-changes going on do not make known their existence by pain or unpleasant sensations. Did space permit I might quote without limit from medical authorities to prove not only the occurrence, but the quite frequent occurrence, of organic changes of structure in their "latent form." The index of almost any text-book on "Pathology," or "Practice," will direct the reader to ample evidence on this point. I will, however, cite one or two well-known authors. Prof. George B. Wood, of Philadelphia, remarks[1] that "sometimes inflammation" (he *must* refer to sub-acute or chronic inflammation) "runs its accustomed course, so far as relates to its effects upon the textures in which it is seated, with scarcely any of those evidences by which its existence in the interior of the body is usually detected, such as *pain*, *disordered function*, and constitutional disturbance. Under such circumstances it is said to be latent, and often escapes detection."[2]

Prof. Austin Flint ("Practice of Medicine," pp. 307, 308) refers to cases of what he calls "spontaneous" or "idiopathic endocarditis" (organic modification of the lining membrane of the heart) "which present the physical signs and anatomical characters of the disease *without the first symptom having been noticed either by the patient or his physician.*" The terms "latent pleurisy," "latent phthisis," "latent pneumonia," etc., are familiar to every pathologist. With regard to this latter disease I cannot refrain from inserting one other citation from the "Works of Dr. Thomas Addison" (*see* "New Sydenham Society's Publications," article "Pneumonia," p. 11). Dr. Addison remarks that Laennec referred to *pneumonia without symptoms* as of rare but occasional occurrence, and adds: "I am convinced that these reputed deviations and exceptions, regarded as obscure, are of extremely frequent occurrence; and that they are met with at every period of life, and in every variety of constitution; and that they are very far indeed from being limited to old persons, or to what have been called complicated cases. . . . Cases with symptoms are in truth themselves the exceptions in a pathological sense; and, although most frequently met with in practice, are in fact cases of complication." This most apt statement is replete with wisdom, and true to Nature. Truly, the simplest form of the disease, that in which the tissue-changes are gradual (chronic), and without symptoms (latent), is rarely met with *in practice*, because the pathological evolution has followed so closely its designed course undisturbed, that the physician is never

[1] "Practice of Medicine," vol. i., p. 38.

[2] Dr. Wood, in here using the term "inflammation," is still possessed with the old error (long ago set aside by the researches of Dr. Handfield Jones and others), that the growth of fibrous (connective) tissue (the supposed "effect of inflammation upon the textures in which it is seated"), is always due to inflammation. Really this abnormal growth of fibrous tissue is a "new formation," the result of an evolutionary process, and is found after death from inflammation only because it *preceded the inflammatory process*, and was by this latter brought to a fatal termination.

sent for and never needed any more than he would be in a case of undisturbed *physiological* evolution. Both are more or less precarious conditions, liable to disturbance and complication; but, while *un*complicated and *un*disturbed, they are both equally conservative, equally devoid of symptoms, and seldom come under the surveillance of the practitioner. Thus the supposed "insidious stealth" and "fatal subtlety" of organic disease is, in reality, the *normal latency* of typical pathological evolution.

It is almost unnecessary to add that latent changes are of necessity slow; hence the two qualities of *chronicity* and *latency* go hand-in-hand, and both are wanting in supervening acute inflammatory complications.

The third quality which we have said belongs to organs developed (or developing) physiologically is, *conformity of structure to a fixed typical standard.*

It may, perhaps, be less easy to point out instances of conformity to a fixed type of structure in pathological formations, for the reason, among others, that pathological evolutionary processes are more often interrupted and made to deviate from their intended type than those which are strictly physiological. Organisms follow the course of physiological evolution easily and happily; pathological evolution is something superadded, and, while conservative, is still the result of unnatural external surroundings, and is therefore less easy and auspicious. Furthermore, we may be less familiar with the finished standard of structure which a typical pathological growth is aiming to reach, than we are with one that is physiological, because the former are more rare than the latter, and hence less frequently observed and studied; physiology occurs in every organism; pathology only in some. Physiological organisms may be observed in great numbers together; pathological ones are exceptional and isolated. The typical standard of physiological development is known, because its existence has been believed in and consequently searched for; the standard type of pathological new formations is not so exactly known, because its existence has not been so universally acknowledged, and hence not so diligently sought after.

Again, organisms undergoing pathological evolution frequently die from the direct effect or remote results of acute inflammation, and here the designed type of structure is obscured by the inflammatory process, so that what it *would have been* in the absence of inflammation cannot always be made out. True, as we have before seen, organisms undergoing physiological evolution die in the same way, and therefore present the same obscurity. In the latter case, however, we observe that, while the designed type of development is obscured in the inflamed parts, the remainder of the organs have pursued *their* physiological development unimpaired. In pathological evolution this is not the case; that is to say, the organs remaining not in-

flamed do not present unimpaired pathological evolution, but, on the contrary, furnish still additional instances of physiological development. It is chiefly, therefore, in cases of accidental sudden death from violence that the designed type of development (both pathological and physiological) can be studied best at all. But here, again, specimens of pathological evolution would occur less often than those that are physiological: first, because the whole number of pathological cases is less than the physiological ones; and, second, because individuals undergoing pathological development are less exposed to the liability of death by violence; they, like young individuals undergoing physiological evolution, require more rest, warmth, and frequent feeding, and are less strong and vigorous, than others whose physiological development has been completed, and who are, therefore, more disposed to cope with the risks and hardships of out-door life and labor, under which circumstances death from violence more frequently occurs.

At any rate, it is nothing else than an axiomatic proposition that similar organisms, impressed with similar stimuli, under similar circumstances, will lead to the development of similar structures. Now, it is evidently only by the rarest possibility that we could meet, in the civilized human subject, with a succession of instances in which all these conditions had prevailed. In man and domesticated animals, it is even observed that *physiological* growth differs widely, but, within certain limits, in different individuals of the same age, species, etc.: it is only in wild animals and plants that we observe uniformity of type; much less, then, need we expect to find this uniformity in evolutionary processes that are pathological; especially, too, when it is only sought for in man and domestic animals.

Finally, notwithstanding the difficulties I have mentioned, enough subservience to a fixed type on the part of pathological new formations has been observed, especially in cases where the new growth and its cause have been limited and simple, to warrant the assertion that pathological evolution in this respect is analogous with physiological development.

This analogy may be further established by considering various other disturbing conditions (in addition to cold) which act disastrously alike in the two kinds of evolution; but this may be reserved for a subsequent paper, when we may also present a *new method of study*, based upon the views herein laid down, and by the pursuit of which it is possible the nature, cause, and prevention of disease, may be investigated more after the manner of the exact sciences.

# THE MICROSCOPE AND ITS MISINTERPRETATIONS.

By JOHN MICHELS.

THE old adage that "seeing is believing" has long been exploded, and folks nowadays receive with caution the impressions conveyed by their eyesight.

There is still, however, a fixed idea with many people that, when the human sight is aided by powerful and correctly-constructed optical instruments, full reliance can be placed upon such united powers, and that the investigator may record that which he believes he sees, as veritable and established facts.

In contradiction of such belief, I shall place before the reader some curious results, which will show that the utmost caution is required by those using optical instruments for the elucidation of scientific problems or ordinary research.

Quite an interesting paper could be written upon the optical delusions with which astronomers have to contend in the use of the telescope, but I propose to confine my remarks to the difficulties

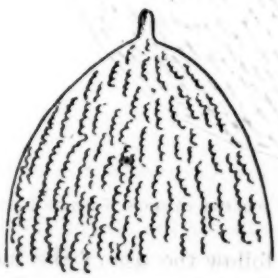


FIG. 1.—DRAWING BY DR. PIGGOTT, SHOWING THE BEADED MARKINGS ON PODURA-SCALE.

which beset the path of the microscopist, in obtaining truthful and accurate results, while using the microscope, leading to the most contradictory statements from men whose powers of observation and skill in the use of the instrument are admitted.

Those who make use of a microscope for the first time are usually fascinated by the wonderful and beautiful appearances presented, and, having illuminated the object under examination with a flood of light, and focused it to their satisfaction, congratulate themselves upon the ease with which they have handled the instrument, and fondly believe they have attained to a knowledge of its use. More extended study, however, and the use of high powers with the more complicated pieces of apparatus, soon convince the student that the instrument requires the most delicate manipulation, and that much practice is necessary before its true powers are developed.

Until full command over a microscope has been acquired, the most contradictory and perplexing results are obtained by those who use high powers in the examination of difficult objects, especially if the subject is very transparent. Things examined yesterday appear quite different to-day, both in form and color; and, even while the eye is still fixed upon the object, a slight change in the position of the mirror will alter its appearance, or present entirely new features.

Again, an object mounted in different mediums, or without any, will present the most varied appearances, and the honest investigator is thus embarrassed to decide which is the true form.

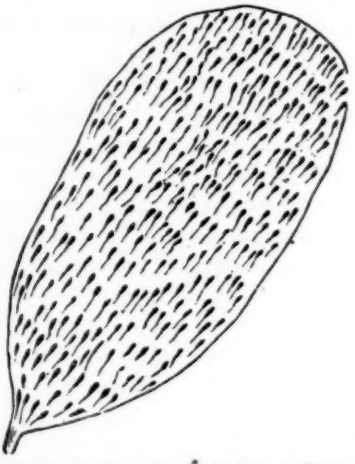


FIG. 2.—SAME SCALE FOCUSED TO SHOW NOTE OF EXCLAMATION MARKS.

These complications follow the use of the instrument through all its stages; but, when the causes are well understood, the difficulties are reduced to a minimum, and even turned to account in the examination of difficult objects.

Great success in the use of the microscope can only be obtained by the skillful manipulation of the light, and he that is not acquainted with the numerous schemes, devices, and contrivances in its management, might as well be in the dark; no directions here avail, and nothing but diligent and constant practice will render the student efficient in this respect.

I once stood an hour watching a leading London optician struggling to show me the true markings of a diatom with a new object-glass he had recently constructed, with which he had had no previous difficulty. He at last gave up the attempt in despair. Of course, an objective that has once performed a specific test will do so again. In this case, the only thing in fault was the management of the light. This had disgraced the object-glass, and enraged its maker.

In contrast with the above case, I may mention the real pleasure

I experienced in witnessing the skill of a professional microscopist of this country. In his hands, all difficulties appeared to vanish, and he showed me one of the most difficult objects known, with marvelous promptitude.

But, to return to my subject: To enable the student to familiarize himself with the true power of the microscope, and to train his eyes to detect errors of vision, certain well-known test-objects are in general use; which are also convenient to test the quality and power of objectives. A favorite object of this class is the scale of the Podura, a minute insect, which dwells in remote nooks of dark and damp cellars, and similar localities.

This scale is usually mounted dry, and, when viewed under the compound microscope with suitable objectives, presents a surface studded with marks similar to the well-known note of exclamation (!)

This test-object has been for years the delight of microscopists possessing high powers, and a sharp definition of its peculiar markings as above mentioned was accepted as its true appearance and form.

For twenty-five years this scale was under constant examination by every grade of microscopists, from the grandees of the Royal Microscopical Society to the humble tyro, without any new or special feature being noticed, when on November 10, 1869, Dr. G. W. Royston Piggott, F. R. M. S., read a paper "On High-Power Definition" before the Royal Microscopical Society, and surprised the members by stating

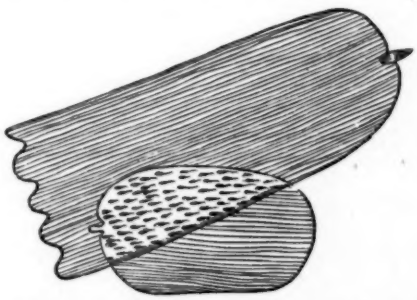


FIG. 3.—SCALE OF AZURE BLUE, PLACED IN POSITION, TO SHOW FALSE MARKINGS SIMILAR TO TEST PODURA-SCALES.—(Piggott.)

that all these years they had been gazing at the podura-scale, but had never yet seen its true markings. Dr. Piggott's paper described very fully what he had discovered as the true markings, and illustrated it with drawings which represented them to be distinctly of a beaded character; in fact, as dissimilar from the old accepted idea of their form as contrast could depict them.

Every microscopist was now hunting poduræ, and cellars damp and dismal were ransacked for the little scale-bearers, doubtless to the astonishment of numerous colonies of spiders, who must have been much provoked by this invasion, and thus commenced a contro-

versy which is not yet concluded. Men equally eminent have taken opposite sides and expressed the most contrary opinions; and I now propose to give a brief *résumé* of what has been said and done in regard to this subject, because the matter is full of instruction to those interested in microscopical research. Not that the markings of the podura are of the slightest importance, or have any scientific significance, but the gravity of the conclusions which are sought hinges upon the fact that, if the views of Dr. Piggott are correct, our most eminent microscopists have been promulgating false and erroneous statements respecting the form of a well-known and common object; and, in whatever light the controversy is viewed, the humiliating confession must be made that they are still unable to determine the correct focus or the proper method of illuminating it.

Dr. Piggott commences by calling resolving the podura-scale "a difficult enterprise," and then describes the beaded appearance in the following manner: "Under a low power, as 80 or 100, the podura-scale is remarkable for its wavy markings, compared to watered silk; raising the power to 200 or 250, and using a side-light, the waviness disappears, and in its place longitudinal *ribbing* appears; with 1,200, they divide themselves into a string of longitudinal beads; but with 2,300 they appear to lie in the same plane and terminate abruptly on the basic membrane; in focusing for the beads attached to the lower side, the beadings appear in the intercostal spaces."

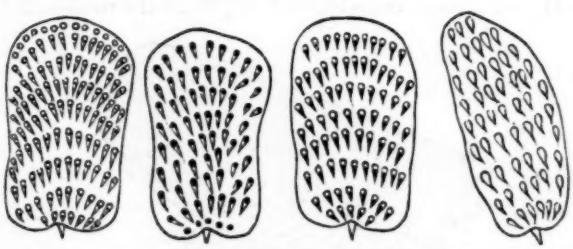


FIG. 4.—THE SAME PODURA-SCALE AS VIEWED UNDER DIFFERENT PHASES OF OBLIQUE LIGHT. —(Westropp.)

Respecting the old received views of the podura-scale, Dr. Piggott says: "With 300 to 500, the celebrated 'spines' appear, according to the size of the scale, as very dark tapering marks (like 'notes of admiration' without the dots ! ! !). To see these clearly with 2,500 has been considered the *ne plus ultra* of microscopical triumphs, and it is consequently with no small diffidence that the writer ventures to traverse the belief of twenty-five years."

Dr. Piggott further states that he reckons these beads to be $\frac{1}{10000}$ to $\frac{1}{180000}$ of an inch in diameter, and that the "spines," which he calls spurious, really embrace in general three or four beads, while the intervening space abounds with beads seen through the basic membrane, and very difficult of observation without special management;

and concludes with the remark that he expects in a few months the podura beadings, such as he described them, will be fully established.

Thus was the gauntlet thrown down, and the challenge was at once accepted by various members of the Society, who, on the conclusion of the reading of the paper, at once disputed the new doctrine. Mr. J. Beck was the first to express an opinion, and rather increased the confusion of the subject by stating that both the spines and the beads were illusory, and that the true structure of the podura-scale was a series of corrugations on one side, and that the reverse side was slightly undulating or nearly smooth, and that the notes of exclamation were due to refraction of light.

Mr. Hogg, the Hon. Secretary of the Society, thought Dr. Piggott in error; he had never seen such appearances as beads; thought probably Dr. Piggott had seen them by using too deep an eye-piece, bad illumination, and drawing out the tube of the microscope to too great an extent; or, perhaps, to a disturbed vision caused by advanced age and presbyopia.

The President, the Rev. J. B. Read, followed by stating that he agreed with the observations made by Mr. Hogg, and such was his faith in the skill of the opticians of the day, that he could not but feel that what he saw with their instruments really existed.

On the same date and occasion on which Dr. Piggott expounded his views, Mr. S. J. McIntire, a member of the same Society, read a paper "On the Scales of Certain Insects of the Order Thysanura." Now, Mr. McIntire, although a recent member, and young in microscopical research, is always listened to on this subject with respect by the Society,

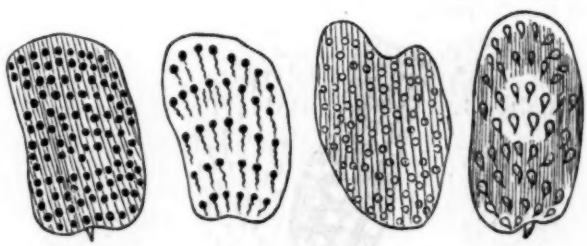


Fig. 5.

having devoted his attention specially to these insects, and shown a patient and intelligent power of observing, not only their structure but their habits; he, in his communication, opposed Dr. Piggott's views, and calls the beads "optical illusions," and concurred with Mr. Beck's statement that the surface of the scale is corrugated, but flatly contradicts him by stating that both sides are alike.

*December* 8, 1869.—The President, the Rev. J. B. Read, stated that he, with Dr. Miller and others, had interviewed Dr. Piggott, and was bound to say he had seen the beaded appearances, and it was clear to

him, *now*, that in the best object-glasses small residuary aberration existed.

This slur upon the best object-glasses brought out Mr. Wenham with a paper in the *Microscopical Journal* of June, 1870, in which he repudiated such error, and described the beaded appearance as an illusion, obtained by a trick of illumination, and by examining the scale with the microscope out of focus.

At the June meeting of the Royal Microscopical Society, a letter was read from Colonel Woodward, of Washington, inclosing photographs of the podura-scale, showing what he considered to be the true appearance. These photographs showed the spines. Colonel Woodward, however, reserved his opinion, and asked for a specimen of the true test podura-scale.

Dr. Maddox, in August, exhibited various photographs of podura-scales, which Mr. Wenham commented on in a paper to the *Microscopical Journal* of September following, which merely reiterated his views that the "*spines*" were the true appearance of podura-scales.

The Rev. J. B. Read, in the *Popular Science Review* of April, 1870, appears to accept Dr. Piggott's views entirely, and writes: "I can now see with my own powers what has been before invisible, viz., the beautiful beaded structure of the whole test-scale, as discovered by Dr. Piggott."

It would be tedious to continue the subject and give even an outline of the papers and discussions that have been provoked by this knotty question: I shall, therefore, conclude by stating that Colonel Woodward has since produced two photographs, showing the two aspects of the question; they are made from authentic scales, and are pronounced very perfect.

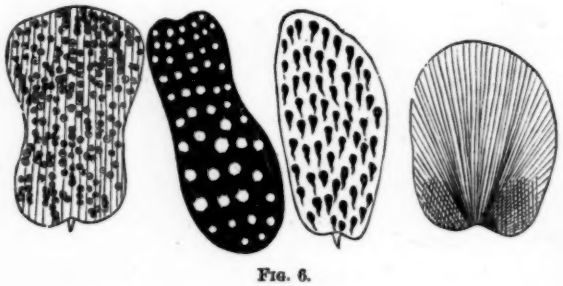


FIG. 6.

In further illustration of the difficulty of obtaining a true and reliable image of an object when viewed under the microscope with high powers, I offer drawings which have been made by Mr. Ralph H. Westropp, B. A., T. C. D., of Allyflin Park, England, and represented at Figs. 4, 5, 6. These figures all represent the same object, a scale of podura viewed under different phases of oblique light; they are interesting as showing the effect produced by the play of light upon a

refractive object. The reader will note that not only the details of the markings are greatly changed, but the very outline of the figures.

The fact that the most skillful microscopists of the age all differ upon the true appearances of a common and not very minute object, and the microscope itself presenting to the vision the most opposite appearances of one and the same object, should act as a caution to those who accept too readily theories based upon microscopical research; and suggests that, in the cause of justice, when life is at stake, single-handed evidence relating to the microscopical examination of apparent blood-stains should be verified at least by a second person before being accepted.

Thus we see that the so-called revelations of the microscope are but hieroglyphics, needing the interpretation of a mind of the highest culture, and that while the microscope is a good servant it is a bad master—mighty in the hands of a Huxley, but as useless to a man without the powers of discrimination as the chisel of Michael Angelo would be in the hands of a Modoc.

## THE MIGRATION OF INLAND BIRDS.

By CHARLES C. ABBOTT, M. D.

AS understood by us, the migration of a bird is simply the desertion of a given locality by that species for a certain, and always the same, portion of each year. As an example, the common house-wren (*Troglodytes ædon*) is migratory, in that it remains in New Jersey[1] only from late in April until late in September, having left its Southern home for six months.

Before endeavoring to determine the causes of this movement on the part of some birds, we must first note the various features characterizing the movement itself; for it may safely be asserted that no two birds migrate alike, although the similarity is marked among the various species of the same family. The most marked feature in migration is the apparent uniformity in the time of its occurrence, i. e., of the dates of the arrivals in spring, and of the departures in autumn. Is this arrival in spring as regular as claimed by some, and supposed by most people? To the casual observer, and, indeed, to many who have for years noted the first appearances of our various birds, the arrival seems to be quite regular; and, curiously enough, we find many such observers insisting that, however late a bird may be any one season, he is never earlier than a given date. Thus we

[1] The observations upon which this essay is based were made by the author during the past sixteen years, while residing at Trenton, New Jersey, and the dates of arrival and departure of the various birds that we give refer solely to them, as seen in that locality.

have been frequently told that a wren is never seen before the 1st of May, and *usually* upon that day they are here in full force. Now, let any one be determined to watch day and night for the first birds of the season; let him wander all day in or about tangled thickets, and sheltered, sunny hill-sides; let him, with sleepless eye, scrutinize every haunt of the birds, and with vigilant ear listen to every faint chirp and far-off twitter, and follow up every undetermined bird-note; let him do this, year after year, from April 1st to 30th, and he will find his note-books teeming with records of "early" birds, that will come and go, all unsuspected by the mid-day observer, who often will insist upon the absence altogether of many a summer songster, that, skulking about, withholds its joyous songs until the woods have welcomed the full company of its kind, that of old have made merry in its shady nooks. The fact is, there is more to be learned about birds, in one hour of the early morning, than in six weeks of mid-day sunshine.

The amount of variation in the dates of arrival of all of our spring birds is really considerable, and in the whole list of migratory inland birds that annually visit New Jersey, either to remain throughout the summer, or are on their way to more northern localities, there is not one that can be considered regular in the time of reaching here, by from twenty to thirty days.

The amount of variation in the dates of arrival, year after year, of the same species, say of the brown thrush, cat-bird, or yellow-breasted chat, is less, however, than that of the time of arrival of allied species; for instance, the various species of thrushes reach us very irregularly. The robin (*Turdus migratorius*) is a resident species; the wood-thrush appears (one or two in a neighborhood) from April 15th to May 10th; the tawny thrush (*Turdus fuscescens*) sometimes later by two weeks, and sometimes absent altogether; the olive-back thrush (*Turdus Swainsoni*) passes by irregularly, as to both time and seasons, and so, too, with the hermit thrush (*Turdus Pallasi*), which, however, occasionally remains throughout the summer. The brown thrush, or "thrasher" (*Harporhynchus rufus*), comes to us by twos and threes as early as April 20th (the first recorded by me this season, 1874, was April 17th), and not until May 3d to the 12th can they be considered as present in full force. The mocking-bird (*Mimus polyglottis*) is irregular, both as to years and dates, and the cat-bird (*Galeoscoptes Carolinensis*), never missing a year, wants the early May foliage developed, that he may skulk therein, yet often in "single blessedness," comes to his last year's haunts, and is wonderfully ingenious in his efforts to conceal himself in the leafless thickets of early April, keeping ever close to the ground, and never venturing upon the slightest attempt at a song.

The many notes we have made with reference to the warblers (*Sylvicolidæ*) also indicate a great degree of irregularity and uncertainty in their migratory movements. This applies to these birds as

a family not only, but to all of the various species separately, of which a score or more pass through the State as a general thing. During certain seasons we have noticed a marked preponderance of some one or two warblers, which for seasons following were much less common than many others. Thus, in 1860, 1864, 1867, and 1872, the common redstarts (*Setophaga ruticilla*) were very abundant, not only about their natural haunts, but within the city limits, and scores of them could be seen climbing over and flitting through the branches of the shade-trees of the less-frequented streets. Since 1872 these birds have not been so numerous as usual, and far less so than many other warblers, such as the yellow-rumped (*Dendroica coronata*), the black-throated blue (*D. cærulescens*), or even the chestnut-sided (*D. Pennsylvanica*).

Unlike the thrushes, the warblers seem to be wholly controlled by meteorological influences and sudden changes of the weather, which, unlike some birds, they seem unable to foretell, greatly influence their movements, and certainly delay their northward progress; and yet, while we have frequently known them to be caught in a "north-easter," they are not otherwise affected by it, so far as we could determine, other than by the delay, before mentioned. Even a sudden change from warm, summer-like weather to decided cold did not destroy any of them, apparently, or check their lively movements among the trees.

Let us glance at the well-known and noticed swallows. For five months of every year we have with us, in greater or less abundance, six species of swallows and one "swift," the common chimney-swallow. Of these, one, the rough-winged (*Stelgidopteryx serripennis*) is comparatively rare, and known only to ornithologists; the white-bellied (*Hirundo bicolor*) are not particularly abundant, except during certain seasons; the cliff-swallow (*Petrochelidon lunifrons*) is erratic, now here, about the barns and stables of a circumscribed neighborhood, for several years, and then wholly failing to appear in their former haunts, when spring comes slowly up this way, to greet May's sleeping blossoms. Not so, however, with the barn-swallow (*Hirundo horreorum*); with a variation in date of arrival of about ten days, we have come to us, in May, our full complement of these beautiful birds. They have decreased in numbers during the past thirty years, so observant old farmers have told us, but probably not so much as they think. It is more probably the increase in the numbers of other species that makes the numbers of the barn-swallow seem fewer. The bank-swallow (*Cotyle riparia*), earliest of all, is here literally by millions, and the purple martin (*Progne subis*), in moderate numbers, seldom fails to occupy the boxes placed for its accommodation; while, lastly, the chimney-swallow (*Chætura pelagica*), which really belongs to another family, nearer the humming-birds and goat-suckers, we believe, has never failed to appear in about the same numbers, year after

year. We have fewer instances recorded of single swallows, seen at unusually early dates, than of birds of any other family. Some, indeed, arrive much earlier than do others, as, for instance, the bank-swallow; but the variation in date of arrival, throughout any ten years, is certainly much less than with other birds, and with some of them it is surprisingly regular, but not absolutely so, as so often asserted.

Let us now glance at the peculiarities of this family of birds, and compare them with the thrushes and warblers. One marked difference at once is seen; that is, that the swallows have a wonderful flight-power, and the thrushes and warblers are weak in their powers of flight, positively as well as comparatively: and our observations bear us out in asserting, as a law of migration, that its regularity is in proportion to and solely dependent on the flight-powers of the species. With the entire list of inland birds of New Jersey, we believe this to hold good.

We have already expressed our belief that many birds have the ability to foretell a coming storm. As this is not directly connected with the subject of our essay, as we are now considering it, we will pass to another feature of this prophetic power, as it apparently is, in birds, and that is, their ability to judge of the general character of the coming season, by a visit of a few days' duration early in spring. We have so frequently noticed that certain birds, common to a locality during the summer, occasionally fail to visit it, except one or two individuals, that in April come for a few days, that it has appeared to us that these "pioneer" birds saw satisfactory reasons for believing that there would be a scarcity of food, and so return to meet their fellows, and informing them, they all depart to "fresh fields and pastures new," just as a single crow, discovering danger, will turn a whole colony from their course as they are going to their roosting-place. This, be it understood, is our supposition, and may be wholly untrue; but how are we to interpret the meaning of any habit or particular movement of a bird, except by the human standard? An act on the part of a bird is intelligible to us only as we would interpret a corresponding act in man; and these acts in birds and men, producing allied results, indicate that close connection between all animal life which is so readily comprehended from an evolution stand-point. Now, as an instance of this "foretelling" power in birds, we noted, during the past spring, the arrival of the first chewink (*Pipilo erythrophthalmus*) on April 27th. Busily among the dried leaves and tangled briers it hopped, enlivening the thicket with its constant song just as a dozen of its kind had done throughout the preceding summer. In a few days it had disappeared, and not a chewink has been seen or heard for nearly six months. Now a few are noticed on their way south from the country north of us. This locality is one where these birds usually congregate, and we have often found a dozen nests in the limits of the spot. But a few miles away, these birds were as abundant as usual. In

two ways we can explain the absence of these birds: either those that were accustomed to occupy it went to a new locality, and the single bird that had preceded them, finding his companions did not come, left, rather than remain alone; or he left to announce that food would be scarce, for it must be remembered, as Darwin has remarked, "most animals and plants keep to their proper homes, and do not needlessly wander about; we see this, even with migratory birds, which almost always return to the same spot." At any rate, the summer of 1874, in this neighborhood, was the driest in the past forty years, and it seemed as if the chewink knew what was coming. So, at least, we believe. During this season we noted the entire absence, during the summer, of several migratory birds, common, as a rule, and a very marked decrease in the numbers of those that did appear; but, at the same time, our note-books mention the arrival of one or more individuals of every one of our migratory birds. Many, like the chewink, foresaw what was coming and acted accordingly. It would be most interesting to determine if insect-life was less abundant than usual during the past summer, but concerning this we have only to note, as suggestive that it was so, a marked freedom of the fruit-trees and fruit itself from the attacks of their insect enemies.

Another feature of the migration of our inland birds must here be briefly referred to; and that is, the failure of late years of certain species to come, as a rule, as far north as New Jersey; and also the habit, now fully acquired by others, of remaining throughout the year, when, but a comparatively short time ago, these same birds were truly migratory.

As an instance: the summer red-bird (*Pyranga æstiva*), twenty years ago, was a regular visitor to Central New Jersey, arriving about May 1st and remaining until October. It nested on trees, frequently in apple-orchards, laying pretty purple-blotched, green eggs. It preferred wooded hill-sides with a growth of underbrush, and having a southern exposure. In such situations they were numerous, and to one such locality, in particular, we can well remember the charm they added to the scene by the bright gleam of their plumage as they passed from tree to tree, uttering their peculiar but not melodious notes. For the past fifteen years we have seen not half a dozen individuals, and recorded no nests since 1857. In far scantier numbers the scarlet tanager (*Pyranga rubra*) has taken their place, although this bird is not rare by any means, nor was it so when the preceding species was abundant.

It is much the same with the mocking-bird (*Mimus polyglottis*). Formerly, as regular in its appearance, if not as abundant, as the catbird, it is now among our rarest summer visitors. An occasional pair, selecting some well-tangled thicket, will come late or early, and build their nest, and then half a dozen years may elapse before we see them again. Yet, thirty years ago these birds were common.

As instances of "spring arrivals," as we will class them, that have become resident species, we will first mention the well-known blue-bird (*Sialia sialis*), which, whatever may be the state of the weather, is as lively and full of song from November 1st to April as from April to November; yet it is still considered as a migratory species, and formerly, we doubt not, was so, even in New Jersey. More interest-are the two instances yet to mention, being those of the common yellow-rumped warbler (*Dendroica coronata*), which, in scanty numbers, braves our winters and from the tops of the loftier pines chirps merrily while the snow-flakes fill the air, and later in the winter seeks shelter in protected nooks where the noonday sun has melted the snow and gives us a breath of spring-like air. In several such spots, since February, 1863, when we shot the first "winter" specimen, we have not failed to find several individuals of this species, during each of the winter months, and of their number that thus remain with us there seems to be a steady increase. The same remarks will apply, in part, to that beautiful but not well-known songster, Bewick's wren (*Thryothorus Bewickii*). They too, in scanty numbers, congregate in sheltered places having a southern outlook, and now, while we are writing (October 29th) we can hear the clear notes of this lively bird as it sits, braving a chilly westerly wind, perched on a leafless branch of a sycamore.

We have noted now the more prominent features in the migratory habits of our inland birds as they come to us in May from the South, save the one fact, the bearing of which upon the subject we cannot determine, that a large proportion of the birds perform the journey by night, the others wholly by day. At least this is the common impression, but it is difficult to demonstrate it. How little, really, we know of the precise *modus operandi* of migration! All through April and May, if astir at the earliest dawn, when the resident birds are just starting their morning songs, we will occasionally hear the welcome notes of some summer bird for the first time. Has it been winging its way northward through the thick, black hours of night, guided by some unknown sense, and no sooner above its old-time haunts than it checks its onward course, and from a familiar tree sings with grateful heart a loud thanksgiving glee?

If we wander about those quiet nooks and by-ways, where the first thrushes and warblers are likely to be seen these same months, we will find all the day long, and evening too, these birds "conspicuous for their absence." Not a chirp or twitter, save of the sparrows and tits of all the year, and the lingering snow-birds that seem to regret leaving our pleasant places. Far into the night we may remain, and only the startled chirp of some disturbed or dreaming bird, or the fret and scolding of little owls, greet our ears. The silence of midnight may pass unbroken, and then, as the first gray streaks of light in the hazy east herald the oncoming day, suddenly a cheerful warble

from some tall cedar or tangled brier-patch breaks the dead silence, and we mark the arrival of the first spring songster of its kind. Did it reach us at sunset, and, resting a few hours, then announce its presence with its cheery song?

Both by day and by night, it may be, they come, but why at all by night, if so, must ever be a great mystery in the strange habit of migration.

Let us next study our birds during the autumn.

A careful examination of the many notes, jotted down at irregular intervals, during the months of September, October, and November, with respect to the departure south of such of our birds as are summer residents, and of some that, having passed the summer in regions far to the north, are now, likewise, seeking their accustomed winter-quarters, indicates a similar apparent regularity in the southward movements of our birds as in spring, and at the same time an actual degree of variation in the dates of departure exceeding the irregularity of the dates of arrival.

If we consider the several circumstances that would necessarily influence their migratory movements, this actual irregularity, in autumn, is just what should be expected; but in the spring, as every bird returns to its own home and former nest, if possible, they will not linger on the way, as they know too well the length of the journey, and the coming duties of incubation speed them on, and we wonder why they are not more regular in their movements. In autumn, all this is changed. Now nothing need hurry them, and, so long as they find an abundance of food, they leisurely move along, just keeping ahead, as it seems, of the chilling frosts of the coming winter, which they can easily endure, but which robs them of the food they must have. This is especially true of insect-eating birds. Considered in this light, we are not surprised to find, then, as a rule, that the warblers, swallows, and such other birds as depend wholly upon insects for their sustenance, leave more promptly and in larger numbers, at one time, than do granivorous birds, and those that *can* subsist on seeds, while they consume insects so long as they can find them.

The weather, both during September and October, is exceedingly variable, and this fact causes the southward movements of the migratory, insect-eating birds equally so, inasmuch as these birds are not larvæ-hunting species, but depend upon insects that can be caught upon the wing, or are to be found resting upon the leaves and twigs of the trees; therefore, just so long as the heavy white frosts are delayed, these insectivorous birds will linger with us. Up to a certain date, about October 1st on the average, these birds largely increase in numbers, consequent upon the daily accession of those from the north, and after the maximum is reached (October 1st or earlier, in accordance with the weather), their number steadily decreases, until but a few stragglers remain.

We feel quite confident that in exceptionally mild winters many more migratory birds winter in Southern New Jersey than ornithologists suspect; and we can see, in the lingering remnant of the great flight of warblers that annually pass through the State, that gradual adaptation to surrounding conditions, on the part of birds, that as centuries roll by, evolve, by that mystery of mysteries, the "survival of the fittest," new species from the old.

Again, long after the true insect-eaters, such as the fly-catchers (*Tyrannidæ*), the vireos (*Vireonidæ*), and the swallows (*Hirundinidæ*), with the chimney-swallow, humming-bird (*Trochilus colubris*), whippoorwill (*Antrostomus vociferus*), night-hawk (*Chordeiles popetue*), and the two cuckoos (*Coccygus Americanus* and *erythrophthalmus*), have passed southward, beyond the limits of the State, and scarcely a leaf is left upon the forest-trees, when not one straggling fly-catcher, in a day's walk, can be found hovering about the many spots so lately tenanted by myriads of their kind, we have yet the pleasure of seeing, in our rambles, many a blithe sparrow, either in the fields or about leafless hedges, or haunting the still green but nearly deserted swampy meadows, and even, late as it is, an occasional grosbeak, as it half conceals its gorgeous ruby and black plumage in some dark cedar, while it utters in broken cadences a fragment of its glorious song.

Of our many sparrows, of which several are resident species, we have noted down for several years, when the severity of the winter was yet to come, even as late as December 14th, the presence of the pretty bay-winged bunting (*Poocætes gramineus*), and in less scanty numbers the quiet little field-sparrow (*Spizella pusilla*). In the wet, reedy meadows, it is not until winter has encased in ice the tangled grasses, that the swamp-sparrow quits its home. For two years past, we have noticed that in the dry upland fields, all through November's hazy Indian summer, the sprightly black-throated bunting (*Euspiza Americana*) still remains, in little companies; and in the quiet woodlands, ever and anon, a retiring grosbeak (*Hedymeles melanocephalus*) lingers, until biting north winds drive him from his summer haunts. Last year, the indigo-bird (*Cyanospiza cyanea*) until the 20th of November remained with us, singing as merrily from the bare branches of the maples as when, during the summer, they cheered their brooding mates with almost ceaseless song. The bobolink, in spite of the persecution they suffer from sportsmen, hold to their reedy haunts, in scattering pairs, often until the first fall of snow, and this same bird—"reed-bird" in autumn (*Dolichonyx oryzivorus*)—being seen so early in the spring, occasionally, may possibly remain, but if so, very rarely. A few red-winged blackbirds (*Agelaius phœniceus*), we know, withstand our winters, and seem to find food somewhere and how, even when the thermometer is at zero.

This difference between the insect-eating and the granivorous

birds, the more prolonged autumn stay of the latter, we think, explains itself. In the spring, there is an object ever in view, while on their journey north—in autumn, their sole care is to be home in time; not so much to escape the coming cold, as to avoid being pinched by hunger.

We have seen that the first frost that but little affects vegetation does materially decrease insect-life; the swallows even anticipate this first frost, and, gathering in immense flocks, wing their way southward long before it comes. We can clearly see that the weather greatly influences, indeed governs, the migratory movements, in autumn, of the insect-eaters. It bids them depart, and, in general, they heed the bidding; but long after this, while there are yet berries, seeds, and fruits, to be obtained, the migratory vegetarians linger, in varying numbers, by the way.

Let us now glance at the abundant and well-known purple grakle or crow-blackbird (*Quiscalus purpureus*). The numbers of this (with us) partially migratory species that remain throughout the winter, as compared with those which are here during the spring and summer months, are about as three to one hundred, as near as we can judge; and, in proportion as the winter is mild, the percentage of those that remain is increased. In Massachusetts, this bird is strictly migratory; the great bulk of those that depart from the north, and from New Jersey, wintering in the Carolinas and Georgia. In this species, therefore, we have an example of a migratory bird that is gradually becoming more and more accustomed, not to the rigors of winter which birds are better able to withstand than they are supposed to be, but to the methods of our winter residents, such as woodpeckers, jays, and titmice, in procuring such food as can then be procured. Food, as a matter of course, and an abundance of it, must necessarily be obtained, and, on examination of the stomachs of grakles killed in January, we have found them filled with a half-digested mass of what appeared to be both animal and vegetable matter. If the grakles that remain during the winter are of a hardier constitution than those that migrate, then, as they mate very early in the year, and before the great bulk of the southern sojourners reach us, their offspring will naturally inherit equally vigorous constitutions, and, like their parents, will be more disposed to remain; at least a large proportion of them will be, and in this way, wholly through natural selection, a *race* of grakles, otherwise undistinguishable from the whole number of this *species*, will be evolved, that in time will wholly replace (?) the now migratory and semi-migratory individuals. If we have now correctly explained a change now in progress, in the habits of this and other species, then can we not, from it, gain a clew to one, at least, of the original causes of the habit of migrating?

But this we will discuss in the concluding part of our essay.

The act of migrating being the passage from one distant point to

another, it is evident that the cause or causes of this movement is one or more that operates at either terminus of the journey. A warbler that winters in Florida, and breeds near the arctic circle, is operated upon by a cause that exists at each terminus, or by two differing causes, each peculiar to its own location, and it is wholly incredible that it is the same cause that induces both the visit to northern regions and the return to a southern clime; therefore there must be at least two causes for the habit—one inducing it in the spring, another compelling the migrating bird to return. If it be possible now to demonstrate what these causes are, and how the same cause can influence all migratory birds, considering that their habits are otherwise so totally different, it will not then necessarily follow that it was the originating cause of the habit. When, indeed, did this migration commence? How far back into the world's geological history must we go, to trace the first bird that was forced to seek another and far-distant land, wherein to rear its young and find for its offspring and itself sufficient food? What conditions of heat and cold, land and water, summer and winter, then obtained, that birds must need fly from coming rigors of scorching sun, or ice and floods, or perish where they were? Was it from living in such a world that migration originated, and became, strangely enough, characteristic of only a fraction of the whole number? How, too, could birds have learned the oncoming of disastrous times, and know just where to seek a safe harbor and secure rest? Clearly it could have been only by a very gradual accumulation of experiences extending over many generations, before the few progenitors of our many birds gained the happy knowledge, that here in the North we have months of sunny summer weather and a wealth of pleasant places. We will not go back, then, of the Glacial period, but rest content with it as having been the starting-point in time of birds' migratory movements. The progenitor of our score of warblers, the one tyrant flycatcher, from which all our species have sprung, the vireos, the goatsuckers, and cuckoos, then very few in species, if indeed there were more than one of each, must have been influenced by the presence of the icy barriers that shut them off for the time being from a vast portion of the northern world, and at the close or closing of that wonderful period it may be that migration commenced, yet why and how, we can but guess. Knowing that it commenced then or recommenced, if previously a feature of bird-life, we have now to inquire what are its apparent causes at present; but, before inquiring into these, may we not, after all, ask if migration be not an inherited habit, the originating causes of which are not now in operation? The conditions not obtaining that necessitate migration, does it not become a case of survival of habit, just as in man many customs now exist, the origin and proper meaning of which are wholly lost? That this is true of the migration of all birds we do not believe, but that it partially holds good with some species we are fully convinced. As an inherited

habit, but one now not absolutely necessary to the bird's welfare, we can see why it should be, as it frequently is, so greatly influenced by surrounding circumstances and conditions.

Taking the movement from its proper starting-point, which we assume to be the movement from south to north, in the three spring months, we must now look for sufficient causes to induce the undertaking of such long journeys. These causes are suggested by the two principal objects effected, on their arrival at their northern destination, viz., rearing of their young, and procuring suitable and sufficient food for both themselves and offspring. If migration is for these two purposes only, then it should prove to be the case that food was not sufficiently abundant in the south for both its resident and migratory birds. This certainly could not have been the case, and we believe, therefore, that migratory movements, at the outset, were to a very limited extent only; a few birds at a time seeking to avoid their enemies, and have undisturbed possession of a locality, by pushing out from their accustomed haunts, for, comparatively speaking, a few miles. The young of such pioneer birds would naturally leave the neighborhood of their nest, and return to their parents' usual haunt with them; but, on the return of another breeding-season, they would themselves seek a resting-place near where they themselves were reared, and the older birds would go to the same nest or nesting-place that a year ago they occupied. This is precisely what occurs now, year after year. Now, as birds increased, century after century, the limits of this northward movement would be extended, until it became in time the journey of thousands of miles that it now is.

Assuming, then, that migration arose for the dual purpose of safe nidification and a certainty of sufficient food, we are met by the ugly question, "Why do not all the southern birds come north?" If, when the whole avi-fauna was concentrated at the south, there was any struggle whatever for favorable feeding or breeding grounds, then, naturally, the weaker would go to the wall, or, in other words, would be driven beyond the limits of their accustomed habitat. These weaker birds, taken together, having once formed the habit of visiting certain localities at stated times for given purposes, or periodically were forced to do so, would vary in their methods of reaching these localities, in their choice of regions wherein to remain, and the length of their annual visit, just in proportion as their habits generally varied from those of both other species of the same family and from species of other families. For instance, to avoid a common enemy, a number of species might have gradually learned to migrate at night; while others, although forced to migrate, had not this same enemy to contend with. In this way, the habit of nocturnal migration would long ago have been formed, and it would, by inheritance, be continued by their descendants, even after the enemy had been long extinct.

Having reached the northern summer homes, and, free from molesta-

tion, reared their broods, clearly, if all things needed for their comfort were to be obtained, it cannot be supposed that these same birds would unnecessarily retrace their long flight to the distant South. This suggests that if we are correct in assuming that birds first appeared in a tropical climate, and from such climate migration started, it is probable that by gradually prolonging their northern visits and accustoming themselves to northern insect and vegetable life, these regions became populated by their resident species. It is evident that the present migratory species are simply compelled to return, and three compelling causes are demonstrable. Primarily, the sudden increase of cold at the close of the brief northern summer, which starts southward those farthest at the north. This accession of intense cold necessarily decreases the amount of food, and the birds are now forced to find it elsewhere. Farther and farther south they come, just in advance of the cold, and slower and slower they proceed, as they enter our more temperate latitude, and here, resting as it were, they linger until a keen frost kills their insect-food, and, scattering the leaves, robs them of their main shelter from their enemies, happily fewer now than formerly; and now still southward they proceed, until they reach a home in lands blessed with perpetual summer.

We have now traced these migratory species from south to north, and back to their southern habitat, and endeavored to point out the several operating causes of the movement as we did so. We have already suggested the possibility of migration being an inherited habit not now necessary. Now, be this true or not, it is evident that the habit is not so fixed a one that ordinary changes in surrounding conditions do not greatly influence it. This, we think, is shown by the irregularity of the movement that really occurs, and the tendency on the part of many species to modify the habit by occasionally halting much to the south of their usual breeding-grounds, and by remaining later and later in autumn; and, again, by the fact that many birds are now only partially migratory, and others by occasionally migrating simply in search of food, thus exhibiting, as it were, traces of a habit they have long lost, as to its full meaning and accomplishment.

In the migration of a bird, then, we see simply a temporary sojourn in a distant locality for the purpose of rearing its offspring in safety; the cause being implied by the term "safety," i. e., freedom from enemies, and an abundance of food.

# SAVAGISM AND CIVILIZATION.[1]

By HUBERT H. BANCROFT.

THE terms savage and civilized, as applied to races of men, are relative and not absolute terms. At best these words mark only broad shifting stages in human progress; the one near the point of departure, the other farther on toward the unattainable end. This progress is one and universal, though of varying rapidity and extent; there are degrees in savagism, and there are degrees in civilization; indeed, though placed in opposition, the one is but a degree of the other. The Haidah, whom we call savage, is as much superior to the Shoshone, the lowest of Americans, as the Aztec is superior to the Haidah, or the European to the Aztec. Looking back some thousands of ages, we of to-day are civilized; looking forward through the same duration of time, we are savages.

Nor is it, in the absence of fixed conditions, and amid the many shades of difference presented by the nations along our Western seaboard, an easy matter to tell where even comparative savagism ends and civilization begins. In the common acceptation of these terms, we may safely call the Central Californians savage, and the Quichés of Guatemala civilized; but between these two extremes are hundreds of peoples, each of which presents some claim for both distinctions. Thus, if the domestication of ruminants, or some knowledge of arts and metals, constitutes civilization, then are the ingenious but half-torpid hyperboreans civilized, for the Esquimaux tame reindeer, and the Thlinkeets are skillful carvers and make use of copper; if the cultivation of the soil, the building of substantial houses of adobe, wood, and stone, with the manufacture of cloth and pottery, denote an exodus from savagism, then are the Pueblos of New Mexico no longer savages; yet in both these instances enough may be seen, either of stupidity or brutishness, to forbid our ranking them with the more advanced Aztecs, Mayas, and Quichés.

We know what savages are; how, like wild animals, they depend for food and raiment upon the spontaneous products of Nature, migrating with the beasts and birds and fishes, burrowing beneath the ground, hiding in caves, or throwing over themselves a shelter of bark, or skins, or branches, or boards, eating or starving as food is abundant or scarce; nevertheless, all of them have made some advancement from their original naked, helpless condition, and have acquired some aids in the procurement of their poor necessities. Primeval man, the only real point of departure, and hence the only true savage, nowhere exists on the globe to-day. Be the animal man ever so low—lower in skill and wisdom than the brute, less active in obtaining food, less ingenious in building his den—the first step out of his houseless, com-

[1] From vol. ii. of "Native Races of the Pacific States."

fortless condition, the first fashioning of a tool, the first attempt to cover nakedness and wall out the wind, if this endeavor springs from intellect and not from instinct, is the first step to civilization. Hence the modern savage is not the prehistoric or primitive man; nor is it among the barbarous nations of to-day that we must look for the rudest barbarism; if proof be wanting, there are the unground edges of the stone implements of Denmark, which denote an order of art lower than that indicated by any relic of the Stone age in America.

Often is the question asked, What is civilization? and the answer comes, The act of civilizing; the state of being civilized. What is the act of civilizing? To reclaim from a savage or barbarous state; to educate; to refine. What is a savage or barbarous state? A wild, uncultivated state; a state of Nature. Thus far the dictionaries. The term civilization, then, popularly implies both the transition from a natural to an artificial state, and the artificial condition attained. The derivation of the word civilization, from *civis*, citizen, *civitas*, city, and originally from *coetus*, union, seems to indicate that culture which in feudal times distinguished the occupants of cities from the ill-mannered boors of the country. The word savage, on the other hand, from *silva*, a wood, points to man primeval, *silvestres homines*, men of the forest, not necessarily ferocious or brutal, but children of Nature. From these simple beginnings both words have gradually acquired a broader significance, until by one is understood a state of comfort, intelligence, and refinement, and by the other humanity wild and beastly.

Guizot defines civilization as "an improved condition of man resulting from the establishment of social order in place of the individual independence and lawlessness of the savage or barbarous life;" Buckle as "the triumph of mind over external agents;" Virey as "the development more or less absolute of the moral and intellectual faculties of man united in society;" Burke as the exponent of two principles, "the spirit of a gentleman and the spirit of religion." "Whatever be the characteristics of a gentleman and the spirit of religion." "Whatever be the characteristics of what we call savage life," says John Stuart Mill, "the contrary of these, or the qualities which society puts on as it throws off these, constitute civilization;" and, remarks Emerson, "a nation that has no clothing, no iron, no alphabet, no marriage, no arts of peace, no abstract thought, we call barbarous."

Men talk of civilization, and call it liberty, religion, government, morality. Now, liberty is no more a sign of civilization than tyranny; for the lowest savages are the least governed of all people. Civilized liberty, it is true, marks a more advanced stage than savage liberty, but between these two extremes of liberty there is a necessary age of tyranny, no less significant of an advance on primitive liberty than is constitutional liberty an advance on tyranny. Nor is religion civilization, except in so far as the form and machinery of

sacerdotal rites and the abandonment of fetichism for monotheism become significant of intenser thought and expansion of intellect. No nation ever practised grosser immorality, or what we of the present day hold to be immorality, than Greece during the height of her intellectual refinement. Peace is no more civilization than war, virtue than vice, good than evil. All these are the incidents, not the essence, of civilization.

That which we commonly call civilization is not an adjunct or an acquirement of man; it is neither a creed nor a polity, neither science, nor philosophy, nor industry; it is rather the measure of progressional force implanted in man, the general fund of the nation's wealth, learning, and refinement, the storehouse of accumulated results, the essence of all best worth preserving from the distillations of good and the distillations of evil. It is a something between men, no less than a something within them; for neither an isolated man nor an association of brutes can by any possibility become civilized.

Further than this, civilization is not only the measure of aggregated human experiences, but it is a living working principle. It is a social transition; a moving forward rather than an end attained; a developing vitality rather than a fixed entity; it is the effort or aim at refinement rather than refinement itself; it is labor with a view to improvement, and not improvement consummated, although it may be and is the metre of such improvement. And this accords with latter-day teachings. Although in its infancy, and, moreover, unable to explain things unexplainable, the science of evolution thus far has proved that the normal condition of the human race, as well as that of physical Nature, is progressional; that the plant in a congenial soil is not more sure to grow than is humanity with favorable surroundings certain to advance. Nay, more, we speak of the progress of civilization as of something that moves on of its own accord; we may, if we will, recognize in this onward movement the same principle of life manifest in Nature and in the individual man.

To things we do not understand we give names, with which, by frequent use, we become familiar, when we fancy that we know all about the things themselves. At the first glance, civilization appears to be a simple matter: to be well clad, well housed, and well fed; to be intelligent and cultured, are better than nakedness and ignorance; therefore it is a good thing, a thing that men do well to strive for—and that is all. But once attempt to go below this placid surface, and investigate the nature of progressional phenomena, and we find ourselves launched upon an eternity of ocean, and in pursuit of the same occult Cause, which has been sought alike by philosophic and barbaric of every age and nation; we find ourselves face to face with a great mystery, to which we stand in the same relation as to other great mysteries, such as the origin of things, the principle of life, the soul-nature. When such questions are answered as, What is attrac-

tion, heat, electricity; what instinct, intellect, soul? Why are plants forced to grow and molecules to conglomerate and go whirling in huge masses through space?—then we may know why society moves ever onward like a river in channels predetermined. At present, these phenomena we may understand in their action partially, in their essence not at all; we may mark effects, we may recognize the same principle under widely-different conditions, though we may not be able to discover what that principle is. Science tells us that these things are so; that certain combinations of certain elements are inevitably followed by certain results, but Science does not attempt to explain why they are so.

In every living thing there is an element of continuous growth; in every aggregation of living things there is an element of continuous improvement. In the first instance, a vital actuality appears; whence, no one can tell. As the organism matures, a new germ is formed, which, as the parent stock decays, takes its place, and becomes in like manner the parent of a successor. Thus, even death is but the door to new forms of life. In the second instance, a body corporate appears no less a vital actuality than the first; a social organism in which, notwithstanding ceaseless births and deaths, there is a living principle. For, while individuals are born and die, families live; while families are born and die, species live; while species are born and die, organic being assumes new forms and features. Herein the all-pervading principle of life, while flitting, is nevertheless permanent, while transient is yet eternal. But, above and independent of perpetual birth and death is this element of continuous growth, which, like a spirit, walks abroad and mingles in the affairs of men. "All our progress," says Emerson, "is an unfolding, like the vegetable bud. You have first an instinct; then an opinion, then a knowledge, as the plant has root, bud, and fruit."

Under favorable conditions, and up to a certain point, stocks improve; by a law of natural selection the strongest and fittest survive, while the ill-favored and deformed perish; under conditions unfavorable to development, stocks remain stationary or deteriorate. Paradoxically, so far as we know, organs and organisms are no more perfect now than in the beginning; animal instincts are no keener, nor are their habitudes essentially changed. No one denies that stocks improve, for such improvement is perceptible and permanent; many deny that organisms improve, for, if there be improvement it is imperceptible, and has thus far escaped proof. But, however this may be, it is palpable that the mind, and not the body, is the instrument and object of the progressional impulse.

Man, in the duality of his nature, is brought under two distinct dominions: materially he is subject to the laws that govern matter, mentally to the laws that govern mind; physiologically, he is perfectly made and non-progressive; psychologically, he is embryonic

and progressive. Between these internal and external forces, between moral and material activities there may be, in some instances, an apparent antagonism. The mind may be developed in excess and to the detriment of the body, and the body may be developed in excess and to the detriment of the mind.

The animal man is a bundle of organs, with instincts implanted that set them in motion; man, intellectually, is a bundle of sentiments, with an implanted soul that keeps them effervescent; mankind in the mass, society—we see the fermentations, we mark the transitions; is there, then, a soul in aggregated humanity as there is in individual humanity?

The instincts of man's animality teach the organs to perform their functions as perfectly at the first as at the last; the instincts of man's intellectuality urge him on in an eternal race for something better, in which perfection is never attained nor attainable; in society, we see the constant growth, the higher and yet higher development; now, in this ever-onward movement are there instincts which originate and govern action in the body social as in the body individual? Is not society a bundle of organs, with an implanted soul of progress, which moves mankind along in a resistless predetermined march?

The strangest part of all is, that though wrought out by man as the instrument, and while acting in the capacity of a free agent, this spirit of progress is wholly independent of the will of man. Though in our individual actions we imagine ourselves directed only by our free-will, yet in the end it is most difficult to determine what is the result of free-will, and what of inexorable environment. While we think we are regulating our affairs, our affairs are regulating us. We plan out improvements, predetermine the best course, and follow it, sometimes; yet, for all that, the principle of social progress is not the man, is not in the man, forms no constituent of his physical or psychical individual being; it is the social atmosphere into which the man is born, into which he brings nothing, and from which he takes nothing. While a member of society he adds his quota to the general fund, and there leaves it; while acting as a free agent, he performs his part in working out this problem of social development, performs it unconsciously, willing or unwilling, he performs it, his baser passions being as powerful instruments of progress as his nobler; for avarice drives on intellect as effectually as benevolence, hate as love, and selfishness does infinitely more for the progress of mankind than philanthropy. Thus is humanity played upon by this principle of progress, and the music sometimes is wonderful: green fields, as if by magic, take the place of wild forests; magnificent cities rise out of the ground, the forces of Nature are brought under the dominion of man's intelligence, and senseless substance is endowed with speech and action.

As to the causes which originate progressional phenomena there are differences of opinion. One sees in the intellect the germ of an

eternal unfolding; another recognizes in the soul-element the vital principle of progress, and attributes to religion all the benefits of enlightenment; one builds a theory on the groundwork of a fundamental and innate morality; another discovers in the forces of Nature the controlling influence upon man's destiny; while yet others, as we have seen, believe accumulative and inherent nervous force to be the media through which culture is transmitted. Some believe that moral causes create the physical; others, that physical causes create the moral.

Thus Mr. Buckle attempts to prove that man's development is wholly dependent upon his physical surroundings. Huxley points to a system of reflex actions—mind acting on matter, and matter on mind—as the possible culture-basis. Darwin advances the doctrine of an evolution from vivified matter as the principle of progressive development. In the transmutation of nerve-element from parents to children, Bagehot sees "the continuous force which binds age to age, which enables each to begin with some improvement on the last, if the last did itself improve; which makes each civilization not a set of detached dots, but a line of color, surely enhancing shade by shade." Some see in human progress the ever-ruling hand of a Divine Providence, others the results of man's skill; with some it is free-will, with others necessity; some believe that intellectual development springs from better systems of government, others that wealth lies at the foundation of all culture; every philosopher recognizes some cause, invents some system, or brings human actions under the dominion of some species of law.

As in animals of the same genus or species, inhabiting widely-different localities, we see the results of common instincts, so in the evolutions of the human race, divided by time or space, we see the same general principles at work. So, too, it would seem, whether species are one or many, whether man is a perfectly created being or an evolution from a lower form, that all the human races of the globe are formed on one model and governed by the same laws. In the customs, languages, and myths, of ages and nations far removed from each other in all social, moral, and mental characteristics, innumerable and striking analogies exist. Not only have all nations weapons, but many who are separated from each other by a hemisphere use the same weapon; not only is belief universal, but many relate the same myth; and to suppose the bow and arrow to have had a common origin, or that all flood-myths, and myths of a future life, are but offshoots from Noachic and Biblical narratives, is scarcely reasonable.

It is easier to tell what civilization is not, and what it does not spring from, than what it is and what its origin. To attribute its rise to any of the principles, ethical, political, or material, that come under the cognizance of man, is fallacy, for it is as much an entity as any other primeval principle; nor may we, with Archbishop Whately,

entertain the doctrine that civilization never could have arisen had not the Creator appeared upon earth as the first instructor; for, unfortunately for this hypothesis, the aboriginals supposedly so taught, were scarcely civilized at all, and compare unfavorably with the other all-perfect works of creation; so that this sort of reasoning like innumerable other attempts of man to limit the powers of Omnipotence, and narrow them down to our weak understandings, is little else than puerility.

Nor, as we have seen, is this act of civilizing the effect of volition; nor, as will hereafter more clearly appear, does it arise from an inherent principle of good any more than from an inherent principle of evil. The ultimate result, though difficult of proof, we take for granted to be good, but the agencies employed for its consummation number among them more of those we call evil than of those we call good. The isolated individual never, by any possibility, can become civilized like the social man; he cannot even speak, and without a flow of words there can be no complete flow of thought. Send him forth away from his fellow-man to roam the forest with the wild beasts, and he would be almost as wild and beastlike as his companions; it is doubtful if he would ever fashion a tool, but would not rather with his claws alone procure his food, and forever remain as he now is, the most impotent of animals. The intellect, by which means alone man rises above other animals, never could work, because the intellect is quickened only as it comes in contact with intellect. The germ of development therein implanted cannot unfold singly any more than the organism can bear fruit singly. It is a well-established fact that the mind without language cannot fully develop; it is likewise established that language is not inherent, that it springs up between men, not in them. Language, like civilization, belongs to society, and is in no wise a part or the property of the individual.

We may hold, then, *a priori*, that this progressional principle exists; that it exists not more in the man than around him; that it requires an atmosphere in which to live, as life in the body requires an atmosphere which is its vital breath, and that this atmosphere is generated only by the contact of man with man. Under analysis this social atmosphere appears to be composed of two opposing principles —good and evil—which, like attraction and repulsion, or positive and negative electricity, underlie all activities. One is as essential to progress as the other; either, in excess or disproportionately administered, like an excess of oxygen or of hydrogen in the air, becomes pernicious, engenders social disruptions and decay, which continue until the equilibrium is restored; yet all the while with the progress of humanity the good increases, while the evil diminishes. Every impulse incident to humanity is born of the union of these two opposing principles. For example, as I have said, and will attempt more fully to show further on, association is the first requisite of progress.

But what is to bring about association? Naked nomads will not voluntarily yield up their freedom, quit their wanderings, hold conventions and pass resolutions concerning the greatest good to the greatest number; patriotism, love, benevolence, brotherly kindness, will not bring savage men together; extrinsic force must be employed, an iron hand must be laid upon them which will compel them to unite, else there can be no civilization; and to accomplish this first great good to man—to compel mankind to take the initial step toward the amelioration of their condition—it is ordained that an evil, or what to us of these latter times is surely an evil, come forward—and that evil is war.

Primeval man, in his social organization, is patriarchal, spreading out over vast domains in little bands or families, just large enough to be able successfully to cope with wild beasts. And in that state humanity would forever remain did not some terrible cause force these bands to confederate. War is an evil, originating in hateful passions and ending in dire misery; yet without war, without this evil, man would forever remain primitive. But something more is necessary. War brings men together for a purpose, but it is insufficient to hold them together; for, when the cause which compacted them no longer exists, they speedily scatter, each going his own way. Then comes in superstition to the aid of progress. A successful leader is first feared as a man, then reverenced as a supernatural being, and finally himself, or his descendant, in the flesh or in tradition, is worshiped as a god. Then an unearthly fear comes upon mankind, and the ruler, perceiving his power, begins to tyrannize over his fellows. Both superstition and tyranny are evils; yet, without war, superstition, and tyranny, dire evils, civilization, which many deem the highest good, never by any possibility, as human nature is, could be. But more of the conditions of progress hereafter; what I wish to establish here is, that evil is no less a stimulant of development than good, and that in this principle of progress are manifest the same antagonism of forces apparent throughout physical Nature; the same oppugnant energies, attractive and repulsive, positive and negative, everywhere existing. It is impossible for two or more individuals to be brought into contact with each other, whether through causes or for purposes good or evil, without ultimate improvement to both. I say whether through causes or for purposes good or evil, for, to the all-pervading principle of evil, civilization is as much indebted as to the all-pervading principle of good. Indeed, the beneficial influences of this unwelcome element have never been generally recognized. Whatever be this principle of evil, whatever man would be without it, the fact is clearly evident that to it civilization, whatever that may be, owes its existence. "The whole tendency of political economy and philosophical history," says Lecky, "which reveal the physiology of society, is to show that the happiness and welfare of mankind are

evolved much more from our selfish than what are termed our virtuous acts." No wonder that devil-worship obtains, in certain parts, when to his demon the savage finds himself indebted for skill not only to overthrow subordinate deities, but to cure diseases, to will an enemy to death, to minister to the welfare of departed friends, as well as to add materially to his earthly store of comforts. The world, such as it is, man finds himself destined for a time to inhabit. Within him and around him the involuntary occupant perceives two agencies at work; agencies apparently oppugnant, yet both tending to one end—improvement; and Night or Day, Love or Crime, leads all souls to the Good, as Emerson sings. The principle of evil acts as a perpetual stimulant, the principle of good as a reward of merit. United in their operation, there is a constant tendency toward a better condition, a higher state; apart, the result would be inaction. For, civilization being a progression and not a fixed condition, without incentives, that is without something to escape from and something to escape to, there could be no transition, and hence no civilization.

Had man been placed in the world perfected and sinless, obviously there would be no such thing as progress. The absence of evil implies perfect good, and perfect good perfect happiness. Were man sinless and yet capable of increasing in knowledge, the incentive would be wanting, for, if perfectly happy, why should he struggle to become happier? The advent of civilization is in the appearance of a want, and the first act of civilization springs from the attempt to supply the want. The man or nation that wants nothing remains inactive, and hence does not advance; so that it is not in what we have but in what we have not that civilization consists. These wants are forced upon us, implanted within us, inseparable from our being; they increase with an increasing supply, grow hungry from what they feed on; in quick succession, aspirations, emulations, and ambitions, spring up and chase each other, keeping the fire of discontent ever glowing, and the whole human race effervescent.

The tendency of civilizing force, like the tendency of mechanical force, is toward an equilibrium, toward a never-attainable rest. Obviously there can be no perfect equilibrium, no perfect rest, until all evil disappears, but in that event the end of progress would be attained, and humanity would be perfect and sinless.

Man at the outset is not what he may be, he is capable of improvement, or rather, of growth; but childlike, the savage does not care to improve, and consequently must be scourged into it. Advancement is the ultimate natural or normal state of man; humanity on this earth is destined some day to be relatively, if not absolutely, good and happy.

The healthy body has appetites, in the gratification of which lies its chiefest enjoyment; the healthy mind asserts more and more its independence. Increasing skill yields ever-increased delights, which

encourage and reward our labor. This, up to a certain point; but with wealth and luxury comes relaxed energy. Without necessity there is no labor; without labor no advancement. Corporeal necessity first forces corporeal activity; then the intellect goes to work to contrive means whereby labor may be lessened and made more productive.

The discontent which arises from discomfort lies at the root of every movement; but, then, comfort is a relative term, and complete satisfaction is never attained. Indeed, as a rule, the more squalid and miserable the race, the more are they disposed to settle down and content themselves in their state of discomfort. What is discomfort to one is luxury to another; "the mark of rank in Nature is capacity for pain;" in following the intellectual life, the higher the culture the greater the discontent; the greater the acquisition, the more eagerly do men press forward toward some higher and greater imaginary good. We all know that blessings in excess become the direst curses; but few are conscious where the benefit of a blessing terminates and the curse begins, and fewer still of those who are able thus to discriminate have the moral strength to act upon that knowledge. As a good in excess is an evil, so evil as it enlarges outdoes itself and tends toward self-annihilation. If we but look about us, we must see that to burn up the world in order to rid it of gross evil—a dogma held by some—is unnecessary, for accumulative evils ever tend toward reaction. Excessive evils are soonest remedied; the equilibrium of the evil must be maintained, or the annihilation of the evil ensues.

Institutions and principles essentially good at one time are essentially evils at another time. The very aids and agencies of civilization become afterward the greatest drags upon progress. At one time it would seem that blind faith was essential to improvement, at another time skepticism—at one time order and morality, at another time lawlessness and rapine; for so it has ever been, and whether peace and smiling plenty, or fierce upheavals and dismemberments predominate, from every social spasm as well as fecund leisure, civilization shoots forward in its endless course. The very evils which are regarded as infamous by a higher culture were the necessary stepping-stones to that higher life. As we have seen, no nation ever did or can emerge from barbarism without first placing its neck under the yokes of despotism and superstition; therefore, despotism and superstition, now dire evils, were once essential benefits. No religion ever attained its full development except under persecution. Our present evils are constantly working out for humanity unforeseen good. All systems of wrongs and fanaticisms are but preparing us for and urging us on to a higher state.

If, then, civilization is a predestined, ineluctable, and eternal march away from things evil toward that which is good, it must be that throughout the world the principle of good is ever increasing and that

of evil decreasing. And this is true. Not only does evil decrease, but the tendency is ever toward its disappearance. Gradually the confines of civilization broaden; the central principle of human progress attains greater intensity, and the mind assumes more and more its lordly power over matter.

The moment we attempt to search out the cause of any onward movement we at once encounter this principle of evil. The old-time aphorism that life is a perpetual struggle; the first maxim of social ethics, "The greatest happiness to the greatest number;" indeed, every thought and action of our lives points in the same direction. From what is it mankind is so eager to escape? With what do we wrestle? For what do we strive? We fly from that which gives pain to that which gives pleasure; we wrestle with agencies which bar our escape from a state of infelicity; we long for happiness.

There is another thought in this connection well worthy our attention. In orthodox and popular parlance, labor is a curse entailed on man by vindictive justice; yet, viewed as a civilizing agent, labor is man's greatest blessing. Throughout all Nature there is no such thing found as absolute inertness; and, as in matter, so with regard to our faculties, no sooner do they begin to rest than they begin to rot, and even in the rotting they can obtain no rest. One of the chief objects of labor is to get gain, and Dr. Johnson holds that "men are seldom more innocently employed than when they are making money."

Human experience teaches, that in the effort is greater pleasure than in the end attained; that labor is the normal condition of man; that in acquisition, that is progress, is the highest happiness; that passive enjoyment is inferior to the exhilaration of active attempt. Now imagine the absence from the world of this spirit of evil, and what would be the result? Total inaction. But, before inaction can become more pleasurable than action, man's nature must be changed. Not to say that evil is a good thing, clearly there is a goodness in things evil; and in as far as the state of escaping from evil is more pleasurable than the state of evil escaped from, in so far is evil conducive to happiness.

Another more plausible and partially correct assertion is, that by the development of the subjective part of our nature, objective humanity becomes degenerated. The intellectual cannot be wrought up to the highest state of cultivation except at the expense of the physical, nor the physical fully developed without limiting the mental. The efforts of the mind draw from the energies of the body; the highest and healthiest vigor of the body can only be attained when the mind is at rest, or in a state of careless activity. In answer to which I should say that, beyond a certain point, it is true; one would hardly train successfully for a prize-fight and the tripos at the same time; but that the non-intellectual savage, as a race, is physically superior, capable of enduring greater fatigue, or more skillful in muscular exer-

cise, than the civilized man, is inconsistent with facts. Civilization has its vices as well as its virtues, savagism has its advantages as well as its demerits.

The evils of savagism are not so great as we imagine; its pleasures more than we are apt to think. As we become more and more removed from evils, their magnitude enlarges; the fear of suffering increases as suffering is less experienced and witnessed. If savagism holds human life in light esteem, civilization makes death more hideous than it really is; if savagism is more cruel, it is less sensitive. Combatants accustomed to frequent encounter think lightly of wounds, and those whose life is oftenest imperilled think least of losing it. Indifference to pain is not necessarily the result of cruelty; it may arise as well from the most exalted sentiment as from the basest.

Civilization not only engenders new vices, but proves the destroyer of many virtues. Among the wealthier classes energy gives way to enjoyment, luxury saps the foundation of labor, progress becomes paralyzed, and, with now and then a noble exception, but few earnest workers in the paths of literature, science, or any of the departments which tend to the improvement of mankind, are to be found among the powerful and the affluent, while the middle classes are absorbed in money-getting, unconsciously thereby, it is true, working toward the ends of civilization.

That civilization is expedient, that it is a good, that it is better than savagism, we who profess to be civilized entertain no doubt. Those who believe otherwise must be ready to deny that health is better than disease, truth than superstition, intellectual power than stupid ignorance; but whether the miseries and vices of savagism, or those of civilization, are the greater, is another question. The tendency of civilization is, on the whole, to purify the morals, to give equal rights to man, to distribute more equally among men the benefits of this world, to meliorate wholesale misery and degradation, offer a higher aim and the means of accomplishing a nobler destiny, to increase the power of the mind and give it dominion over the forces of Nature, to place the material in subservience to the mental, to elevate the individual and regulate society. True, it may be urged that this heaping up of intellectual fruits tends toward monopoly, toward making the rich richer and the poor poorer, but I still hold that the benefits of civilization are for the most part evenly distributed; that wealth beyond one's necessity is generally a curse to the possessor greater than the extreme of poverty, and that the true blessings of culture and refinement, like air and sunshine, are free to all.

Civilization, it is said, multiplies wants, but then they are ennobling wants, better called aspirations, and many of these civilization satisfies.

If civilization breeds new vices, old ones are extinguished by it. Decency and decorum hide the hideousness of vice, drive it into dark corners, and thereby raise the tone of morals and weaken vice. Thus

civilization promotes chastity, elevates woman, breaks down the barriers of hate and superstition between ancient nations and religions; individual energy, the influence of one over the many, becomes less and less felt, and the power of the people becomes stronger.

Civilization in itself cannot but be beneficial to man; that which makes society more refined, more intellectual, less bestial, more courteous; that which cures physical and mental diseases, increases the comforts and luxury of life, purifies religions, makes juster governments, must surely be beneficial; it is the universal principle of evil which impregnates all human affairs, alloying even current coin, which raises the question. That there are evils attending civilization as all other benefits, none can deny, but civilization itself is no evil.

## FORESTS AND RAINFALL.[1]

THE question of the influence of forests on the hydrology of a region is one that has been warmly discussed. Some men of science, Becquerel for example, hold that forests increase the amount of water received by the soil; while others, Marshal Vaillant among them, assert that forests diminish the quantity. Some *savans*, such as M. Mathieu, sub-director of the Nancy School of Forestry, have endeavored, by way experiment, to get together such facts as might, if they did not set the question at rest, at least clear up some points and supply a portion of the experimental data needed for a full explanation at some future time. M. Mathieu undertook to "determine the amount of rain-water received by the soils of two neighboring districts, one of them covered with timber and the other arable land; and to find out whether, in consequence of the covering of trees which intercepts the rain-water, the soil of the woodland is as abundantly watered as that of the open." His conclusion is, that timbered soils receive as much, and more, rain-water than the open country.

These experiments are of great importance; the results obtained are noteworthy, and, taken in connection with Becquerel's observations, seem to be decisive of the question. Still, in order to meet an objection that might be raised against this mode of experimenting, viz., the difficulty of finding two districts near to one another and fairly comparable, we have made experiments from another point of view, which confirm those made by M. Mathieu.

No matter how you select two neighboring districts, it is not easy to prove that they are absolutely comparable to one another. The amount of rainfall may be seriously affected by the altitude, and particularly the relative altitude; by the situation of the district; by the relief and configuration of the land in the surrounding country; and

[1] Translation of a communication to the French Academy of Sciences, by L. Fautiat and A. Sartiaux.

by other unknown conditions which may in a greater or less degree change the direction or the velocity of the rain-current, or the point and degree of condensation of the watery vapor contained in it.

M. Dausse, in a memoir which appeared in the "Annales des Ponts et Chaussées," uses the following argument: "Rain is formed when a warm and humid wind comes in contact with strata of cold air; and since the air of forests is colder and more humid than that of the open, rain must fall there in greater abundance."

To gauge experimentally the influence of forests on the rainfall of a district, or, in other words, to ascertain the condensing power of forests, we have compared the results obtained in observations made: 1. Above the forest; and 2. At the same altitude, and at so small a distance from the forest, that any observable difference could be attributed only to the influence of the latter.

We now made the following observations in the heart of the forest of Halatte, which embraces 5,000 hectares of land. At the height of about six metres (say 20 feet) above a group of oaks and hornbeams eight or nine metres high, we placed a pluviometer, a psychrometer, maximum and minimum thermometers, and an evaporometer, so as to ascertain at that point the amount of rainfall, the degree of saturation of the air, and the rate of temperature and of evaporation.

In the open air, at the distance of only 300 metres from the forest, and at the same height above the ground as in the former case, we placed similar instruments under the same conditions. With regard to the rainfall and the degree of saturation, we give a summary of the first six months' observations, as follows:

| Months. | Amount of Rainfall. | |
|---|---|---|
| | In the Forest. | In the Open. |
| February, 1874 | 18.75 mm. | 18.00 mm. |
| March, " | 15.00 " | 11.75 " |
| April, " | 27.50 " | 25.75 " |
| May, " | 39.25 " | 35.50 " |
| June, " | 51.25 " | 48.25 " |
| July, " | 40.75 " | 37.75 " |
| Total | 192.50 mm. | 177.00 mm. |

Difference in favor of the forest, 15.50.

| Months. | Degree of Saturation of the Air, in 100ths. | |
|---|---|---|
| | In the Forest. | In the Open. |
| March, 1874 | 71.1 | 70.0 |
| April, " | 64.3 | 64.2 |
| May, " | 64.1 | 60.4 |
| June, " | 60.9 | 60.1 |
| July, " | 54.6 | 53.8 |
| Total | 315.0 | 308.5 |
| Mean | 63.0 | 61.7 |

Difference in favor of the forest, 1.3.

If these observations, which are still made daily, continue to give the same results, it may then be affirmed that forests constitute vast condensing apparatus, and the conclusion will be inevitable that more rain falls in wooded land than on bare and cultivated soil.—*Comptes Rendus.*

## THE CYCLONE IN THE UNIVERSE.

By JAMES MACKINTOSH, M. A.

THE science of meteorology is but of yesterday, and yet it has already developed results which throw light upon the genesis of the universe. It has revealed to us the true nature of atmospheric disturbances throughout time and space. The winds no longer blow where they list, and we hear the sound of them and can tell whence they come and whither they go. We know their producing causes, and can foretell, with a considerable degree of accuracy, their force, duration, and direction. Accordingly, the great majority of civilized countries, including China, the oldest of them, have already established weather bureaus, whose business it is to forewarn the mariner of coming tempests, and to give us all a timely notice when we shall require an umbrella or a great-coat.

While these practical results are exceedingly worthy of attention, and inspire us with the hope that the time shall come when perfected instruments, improved methods, and increased knowledge, shall enable the meteorologist to predict with the utmost certainty every atmospheric disturbance, they yet fall into the shade when compared with the magnificent and luminous conceptions which meteorology has added to cosmological science. It has opened to us visions of beauty and order reaching through infinity and eternity. It has given us a clearer glimpse into the workshop of the Almighty.

The principal scientific result of meteorology is the theory of the cyclone. This is its central idea, the point of reference from which every thing is explained. So long as meteorologists tried to explain storms by encountering currents of wind, as did Dové and his school, so long did the science remain merely a laborious, interminable, and apparently useless collection of tabulated facts. It was then in its empirico-historical stage, and could, at the best, only produce such bare generalizations as isobaric and isothermal lines. Averages and darkness ruled throughout. But, when once the light-giving idea of the cyclone was fully grasped, a heavenly radiance dispelled the uncertain gloom, and the science was at once taken out of the range of the merely empirical, and established securely upon a deductive basis.

What, then, is this light-bringing conception of the cyclone? Briefly, as follows: A cyclone consists essentially of a rapidly-ascend-

ing current of air. This involves two other functions: 1. A rushing in of the air at the under part of the ascending current; 2. An outrushing at the upper. Upon the former of these functions, combined with modifying circumstances, depend the peculiar character and career of the under-currents and of the clouds they bear; upon the latter, combined with the same circumstances, the proportions and direction of motion of the upper currents and of the heavy masses of clouds they bear. There appears to be nothing in the nature of the cyclone itself which can determine the motion of either the upper or under current more toward any one point of the compass than toward the others. This direction of motion relative to the ascending column depends upon the direction and velocity of motion of the latter, and of the atmospheric strata in which the influx and efflux take place, modified to some extent by the differing velocities of revolution of the surface of the earth at different parallels of latitude, by the form of the earth's surface, and by the variation in the constitution of the atmosphere. If the cyclone column and the atmospheric strata which it penetrates move in the same direction, and with the same velocity, the influx and efflux will take place in nearly equal quantity, on all sides of the column. If they move with different velocities, the directions of exaggeration and diminution of the influx and efflux can be calculated in the same way as the direction of a vane on a ship's mast, given the directions and velocities of the motion of the wind and of the ship.

This gives the general idea of the cyclone for all space and time, but not the sources of its power. These are to be found in the less specific gravity, potential or actual, of the lower atmospheric strata as compared with that of the higher. Air, and gases generally, expand when heated, and become specifically lighter. It thus tends to rise above the superincumbent colder air. (We see this illustrated in our chimneys every day.) If the air over the surface of a plain becomes heated by contact with it, its specific levity is increased, and it tends to rise. But the density, and therefore weight of air, the temperature and humidity being the same, is inversely as the pressure upon it. Consequently, so long as the diminution of specific gravity caused by increased temperature is balanced in the strata above by the diminution of pressure due to elevation, the heated air cannot ascend very fast. If it had a chimney to rush up, the case would be different; but, not having one, it can only rise slowly by intermingling itself with the superincumbent air. As soon, however, as the diminution of specific gravity due to higher temperature is greater than that due to diminished pressure, the lower stratum will break itself a way through the air above it, and rush up through the opening. This result may be attained, and is generally reached, by favoring circumstances, long before equilibrium is totally destroyed. When once the heated air has thus at a particular point formed itself a channel of escape, the

warm stratum along the surface of the earth rushes toward the opening, and there ascends, while the colder air above descends to take its place. If the ascending column of heated air remained stationary, it is evident that its supply of warm air would soon be exhausted, and the process therefore speedily come to an end. But this is not so. It moves forward to where there is more heated air, just as one might fancy a chimney to travel after a moving fire. The operation can thus go on for a considerable time.

The ascension of air with a higher *sensible* temperature would not alone suffice to supply the tremendous power of the cyclone. The difference of temperature, even in extreme cases between lower and higher strata, is wholly insufficient to account for the enormous energy developed by our cyclones of hundreds of miles in diameter. We therefore require another source of power. Nor have we far to seek it. The sun's rays falling upon dry earth heat it, and thus raise the temperature of the air in contact with it. But if they fall upon our oceans, lakes, and rivers, or upon moist earth, there is another result, of a somewhat different though equally familiar kind. It is this, that some of the water is converted into steam or vapor. Now, every one knows that no amount of heat can raise the temperature of boiling water if it is unconfined. Where, then, does the heat go to? Plainly it is carried off by the vapor in an insensible or latent condition. It is a demonstrated fact that it requires as much heat to convert a quantity of water into steam as it takes to raise the same quantity 1,000° of temperature. The same amount is required to evaporate water without boiling it. Consequently, when the sun's rays evaporate water, a vast amount of heat becomes insensible to our thermometers. It is not annihilated, however, and all that is required in order to make it manifest is simply to condense the vapor into water again.

When the heated air, as already described, rushes up in a column, it becomes subjected to less and less pressure, because there is less and less air above it. Since air in expanding under pressure produces work, and since heat is an equivalent of work, it expends heat in so doing, and is thus lowered in temperature. Consequently, the ascending air rapidly cools as it rises. Now, this air is carrying large quantities of vapor of water with it, which likewise is cooled by expansion. But you cannot cool vapor at any tension below a certain temperature without condensing it; and so, indeed, it happens. The steam carried up by the cyclone is condensed into rain, snow, or hail, and falls to the earth. In condensing it gives forth the enormous quantity of insensible heat which it received from the sun. This heat is imparted to the ascending current, and thus keeps it warmer and therefore specifically lighter than the strata through which it is rising. The heat of the sun, which had been potential in the vapor, is converted into the energy developed by the cyclone.

We thus see that the cyclone is really a kind of vast steam-engine.

On our earth its furnace is the sun, and its boiler the moist lands, the rivers, lakes, and oceans. But it is evident that its mode of operation would not be substantially affected if the heat were supplied not as in our case from an outside source, but from the original internal heat of the sun or planet itself. So, also, the essential nature of the cyclone would not be altered whatever be the kind of vapor condensed, whether it be of water, of iron, of copper, of gold, or of granite. The above derivation of the power of the cyclone is therefore applicable throughout time and space.

For the condensation of any vapor whatever would present very much the same phenomena as those with which we are familiar. Let us suppose the earth of such a temperature as to keep iron in nearly the same condition relatively as water is now; that is, partly vapor floating in the atmosphere, partly fluid gathered in oceans, lakes, and rivers, and partly like solid snow and ice as in the colder seasons and latitudes. Evaporation would go on at the surface of the fluid iron until the atmosphere became nearly saturated. As soon as condensation began an ascending current would be formed. Toward the bottom of this current the winds would rush in spirals just as they do now. As the vapor of iron rose and came to the strata of less and less pressure and temperature, it would expand, cool, and condense, and descend in molten showers of liquid metal. Or, if the temperature were low enough, or the summit of the storm high enough, a shower of iron hail, or snow, would be the result.

Nor need we stay our imagination here. The time was, when our globe had no solid or liquid nucleus, but was wholly gaseous. It was literally an *atmosphere*, and nothing else. All the matter of the earth then floated, a vast globular ocean of vapor. The power which kept its particles apart was heat. Before these particles could come together and the solid foundations of the world be laid, it was necessary that the heat should be got rid of. The means by which this purpose was accomplished was mainly the cyclone. Around the limits of the vaporous world radiation into empty space could go on rapidly. Not so in the interior. Conduction of heat even along a bar of iron is a very slow process. It is million-fold slower through gas. Hence, the quickest way of carrying the heat from the interior to the summit of the atmosphere, where it might escape, was, to carry up the matter itself which contained a large amount of heat, either actual or potential. This work was accomplished by the cyclone.

Let us endeavor to form some conception of the cyclone of primeval times. Let us fancy ourselves in the solar system ere yet it became separated into insulated worlds, and just as condensation is going on. Gases of different specific gravities tend to intermingle even though at first arranged in separate layers above one another. Many of the gases would also be of nearly the same specific gravity. Hence, although in general the denser gases would tend together toward the

centre, and the lighter toward the summit, there would necessarily be a vast amount of confused intermingling. Hence a cyclone of those times could not be attended by the fall of only one kind of rain, as of molten iron, but by that of many different kinds. Doubtless while some substances, such as granite, fell as snow or hail, others, such as iron, would fall as rain.

Moreover, since the strata would be, in the main, according to their specific gravity, and since some of the gases would evaporate and condense at different temperatures from others, showers of different kinds of metals and stones would tend to form at different altitudes. This would be counteracted, at least in part, by the tendency of the cyclone to reach clear up from the lowest depths to the circumference. That the disturbances in our own atmosphere extend to an immensely greater height than is generally supposed, and probably almost to the extreme limit of the atmosphere, is now certain. In my report on the tornado of May 22, 1873 (Chief Signal-Officer's "Annual Report, 1873"), I showed that in all likelihood it reached, at least, to an altitude of sixteen miles. The cyclones in the sun also appear to extend almost to the summit of his atmosphere, otherwise we could not see them so clearly as we do. Judging also from the nature of the case, we should conclude that the cyclone, amid such a vast assemblage of vapors, arranged in layers, would be likely to extend its dimensions almost from the centre to the circumference; for a disturbance and precipitation in one layer would tend to produce a disturbance and precipitation in the stratum above it, as well as in that beneath it. We have thus presented to our imaginations a vast cyclonic column thousands of millions of miles in height, up which vapors of great variety, and collected at very various altitudes, are rushing with terrific force, and condensing as they go. Those, like granite, that solidify at a high temperature, would freeze in huge blocks which, generating sufficient centrifugal force by the whirling motion, would fly out from the ascending current and rush downward. Substances congealing at different temperatures would thus be likely to be thrown out at different elevations. Much the larger mass of substances, however, would probably be carried up to where the cyclone spread itself out laterally in a huge nimbus-cloud. From that cloud would rush down a fierce deluge of half the substances of the solar system in solid or liquid form. The violence and confusion of the descending hail and rain would be of surpassing grandeur—far more terrible and sublime than that scene described by Milton, where the Satanic host was hurled from the battlements of heaven "with hideous ruin and combustion down to bottomless perdition." All kinds of igneous rocks, mingled with molten metal, chased each other millions of miles down through the fiery gloom. The temperature increased as they descended. Each substance melted and evaporated as it reached the proper temperature, while the substances

more difficult to evaporate continued their downward course. Finally, all would again be reduced to a state of vapor.

What, then, had been accomplished by all this turmoil and activity? Merely this: a large quantity of heat had been conveyed from the interior of the system to the exterior; for this it is which all cyclones accomplish. This it is which lends them their power. On our earth it is the sun's heat mainly which the cyclone carries away to the limits of the atmosphere. In the sun itself it is a portion of the primeval stock of heat which is removed.

The cyclone may therefore be defined as the universal cooler of creation. There is not a sun which lights the midnight sky, or which the telescope has brought within mortal ken, which is not vastly indebted to the cyclone. Though so simple as easily to be understood by a child, it is a powerful means by which the Almighty works. It is a key to very many of the secrets of the universe. When we watch the snow-storm and the rain, we are really watching the method by which God has proceeded in forming his worlds since ever the cooling process began. Thus have the storms raged and the winds howled throughout the universe for countless ages; and by that rain, and snow, and hail, has all the solid and liquid substance of the worlds been formed. Every particle of it has been rained and snowed again and again. Nor is the process yet completed. The cyclone has by no means done its work yet. Its task will be finished only when the last particle of gas is converted into a liquid or solid. It is going on all around us. If there appears to be a balance at present upon the earth, if the solidifying power of the cyclone appears to be at a standstill, it is only because its efforts are counteracted by the extraneous heat we receive from the sun.

The cyclone may also have assisted at the birth of the planets. Those stupendous meteors of thousands of millions of miles of elevation must necessarily have caused immense gaseous masses to bulge out from the general level of the surface of the incipient solar system. This might be sufficient under exceptional conditions, and when the balance between the centrifugal and the centripetal forces was nearly equal, to turn it in favor of the former, and thus generate a planet.

## A CURIOUS QUESTION OF HORSES' RIBS.

By MAX MÜLLER.

SYLVIUS said that man had formerly an intermaxillary bone. If he has it no longer, he ought to have it. In this he was right. The same Sylvius, in his answer to Vesalius, said that Galen was not wrong when he described man as having seven bones in his sternum,

"for," said he, "in ancient times the robust chests of heroes might very well have had more bones than our degenerate day can boast." In this he was wrong.

I take these statements from Mr. Lewes's "Life of Goethe" (p. 343), and I have to confess that I have not verified them. They interested me, however, as bearing on a controversy that has been carried on for some time between scholars and anatomists, viz., whether another animal, the horse, instead of losing, has developed in course of time some bones which it did not originally possess. Horses have now thirty-six ribs; sometimes, it is said, thirty-eight. But there is a passage in the "Rig-Veda," which speaks apparently of only thirty-four ribs in horses. It was M. Piétrement, who, in his work "Les Origines du Cheval domestique d'après la Paléontologie, la Zoologie, l'Histoire et la Philologie" (Paris, 1870), first called attention to this curious statement, and drew from it the conclusion, supported by some very ingenious arguments, that at the time of the Vedic poets, say about 1500 B. C., there existed a race of horses with only thirty-four ribs. Other zoölogists, and more particularly M. Sanson, raised some strong objections, but M. Piétrement replied to them in his "Mémoire sur les Chevaux à trente-quatre côtes des Aryas de l'Époque Védique" (Paris, 1871), and the question is still *sub judice*.

M. Piétrement's reasoning may best be given in his own words:

"In the first place, I would observe that the presence of only thirty-four ribs in an equine race, whether ancient or modern, would not be by any means abnormal, or contrary to the laws of Nature; for it is fully agreed now that the number of these bones is far from being constant in our present horses. Indeed, Chauveau remarks as follows on the number of ribs in the horse: 'We reckon for each lateral half of the thorax eighteen ribs. Not unfrequently we find nineteen, with an equal number of dorsal vertebræ in well-formed horses; but, then, most usually there are only five lumbar vertebræ.'

"On the other hand, we sometimes find in horses of a certain type 'only five lumbar vertebræ, instead of six (which is the usual number in the species *Equus caballus*), the number of the other vertebræ being the same as usual in the horse.'

"When this latter fact was published in France by M. Sanson, it at first met with much opposition, but now it is fully accepted by men of science; and it is justly considered as an indication of the ancient existence of an equine race with five lumbar vertebræ; and the crossing of these horses with horses having six lumbar vertebræ fully accounts for the frequent anomalies of conformation which we find in this region of the vertebral column."

Having by these considerations established the possibility of an ancient race of horses with only thirty-four ribs, M. Piétrement appealed for its reality to a passage in the most ancient literary document of the whole Aryan world, the "Rig-Veda."

The passage in which the thirty-four ribs of the horse are mentioned occurs in the 162d hymn of the first book of the "Rig-Veda Saṁhitā." I translated the whole of that hymn in my "History of Ancient Sanskrit Literature" (1860, p. 553). The hymn is ascribed to

Dīrghatamas, and describes the sacrifice of the horse in very full detail. In the eighteenth verse we read:

"The axe approaches the thirty-four ribs of the quick horse, beloved of the gods. Do you wisely keep the limbs whole, find out each joint and strike."

This passage is curious in many respects. It refutes the statement of Strabo (xv., 54), that the Indians did not slaughter their victims: "They do not slay the victim, but suffocate it, to the end that it may not be offered to the god mutilated, but entire." It also seems to imply that the horses then offered at the sacrifices had only thirty-four ribs. This statement, however, startled even the orthodox commentators in India, and Sāyaṇa remarks in his commentary on this passage, that other animals, such as goats, etc., have only twenty-six ribs, as might be proved by what he considers as far more convincing than ocular evidence, viz., a passage from the "Brāhmaṇas," in which it is said, "Its ribs are twenty-six." In another passage, in his commentary on the "Śatapatha brāhmaṇa," xiii., 5, 1, 18, Sāyaṇa returns to the same subject, but unfortunately that passage, as edited by Prof. Weber, is so corrupt that I at least cannot make sense of it, though it is clear that Sāyaṇa says there that their ribs are thirty-six. Another commentator, Mahīdhara, explaining the horse-sacrifice, as prescribed in the "Yaǵurveda," seems to have no anatomical misgivings, but states that the horse has thirty-four, goats and other animals twenty-six ribs.

I confess that I was myself very much puzzled by the passage in the "Rig-Veda." It was quite clear that the reading ḳatustriṁśat, thirty-four, cannot be called in question; it was equally clear that that number would not have been mentioned except for some special purpose. That it was the habit of the ancient Hindoos to count the various bones of the human or animal skeleton, may be seen in the "Law-book of Yāǵnavalkya," iii., 85, *et seq.* There we read:

"The neck consists of fifteen bones, a collar-bone on each side, and the chin; two at its root, and the same on the forehead, the eyes, and the cheeks, and the nose of firm bone. The ribs with their supports and the Arbudas (*Zippenknorpel*) are seventy-two. Two front-bones, four skull-bones of the head, seventeen bones of the chest, these are the bones of a man."

Similar passages occur elsewhere, and establish the fact that the ancient anatomists of India made a point of knowing the exact number of the bones in the different portions of the bodies both of men and animals.

Not being able to find a satisfactory solution of my difficulty, I applied to Prof. Huxley, and I am glad, with his permission, to print the following letter, which offers a most ingenious, and, to my mind, satisfactory solution:

"26 Abbey Place, N. W.

"My dear Sir: I have been much interested in M. Piétrement's 'Mémoire.' His work 'Les Origines des Chevaux domestiques' is well known to me, but I

had paid no particular attention to his incidental mention of the 34-ribbed Aryan horse.

"M. Piétrement's essay raises three questions. The first, Does the passage of Dîrghatamas's hymn cited necessarily imply that the horse known to him had only thirty-four ribs? The second, Does the passage from Sâyana imply that he asserted of his own knowledge that the horses of his time (in 1400 A. D.) had only thirty-four ribs? The third, Are there any zoölogical arguments in favor of or against the existence of a breed of 34-ribbed horses?

"1. Your Latin version of the solitary Vedic passage upon which M. Piétrement relies, admits the reading, 'The axe cuts through [the] thirty-four ribs of the quick horse,' etc.

"I speak ignorantly, but suppose I am right in assuming that there is no more 'the' in the Sanskrit than in the Latin. Nevertheless, it is upon the presence of this definite article that the question turns. For, without it, the passage may simply mean that the axe cuts through thirty-four ribs out of the thirty-six with which the horse is provided. What makes me think that this may be the proper signification of the passage is the inquiry I put to myself, For what purpose did the sacrificing priest want to cut through the horse's ribs? Surely, in order to disembowel him. But, in order to do this, no one would go through the great trouble and labor of chopping through the bony parts of the ribs of a horse. Moreover, such a proceeding would be incompatible with the objection to mangling the horse's bones, which is strongly displayed elsewhere in the Vedic hymn.

"But every bony rib ends below in a gristly substance, and it is quite easy to cut these 'costal cartilages,' and then, turning them back, along with the breastbone, the cavity of the chest is laid widely open, and the priest readily reaches the heart or the like.

"But, if every rib ends in a cartilage, there must be thirty-six cartilages, and not thirty-four?

"True, but the last pair of ribs is much shorter than the others. It is not needful that all the thirty-six pairs of costal cartilages should be cut through in order to lay the chest thoroughly open; and for sacrificial purposes it may have been inconvenient to cut through more than the thirty-four ribs which lie in front of it.

"If you are laying open a man's chest for a *post-mortem* examination, you go to work exactly as I am supposing the Aryan priest to do. You cut through the rib cartilages on each side and take them away, along with the breast-bone to which they are attached. But, in doing this, you leave at least the last two ribs on each side untouched, because they are free, so that it is not needful to cut them.

"If I were a poet, and made a hymn about a *post-mortem* examination, I might speak of the operator's scalpel 'cutting through the twenty ribs,' without meaning to imply that the man of the period is devoid of his full complement.

"2. Does Sâyana say that the horses of his time had only thirty-four ribs? The passage quoted by you does not seem to me to bear that interpretation at all.

"3. As to the zoölogical aspect of the question. Horses may undoubtedly vary not only in the number of their ribs, but in the number of their dorso-lumbar vertebræ. The latter may be twenty-four (as usual), or twenty-three, as in the cases cited by Sanson, and also by Legh in his 'Handbuch der Anatomie der Hausthiere;' and the former may be eighteen (as usual) or nineteen on each side. Unfortunately, I know of no case on record (and M. Piétrement seems to

have been unable to find one) in which either horse, ass, or other equine animal, had *fewer* than thirty-eight ribs. If a 34-ribbed race of horses ever existed, I think it ought to turn up as a variety now and then. But it does not; and, what is still more to the purpose, we do not find that any of the immediate allies of the horse have fewer than thirty-six ribs; though they may, as in the case of the ass, have only five lumbar vertebræ.

"Without wishing, in the least, to dogmatize, then, I must say that the zoölogical probabilities appear to me to be dead against M. Piétrement's hypothesis; and unless you tell me that the Sanskrit text must mean that Dîrghatamas's horses had thirty-four ribs and no more, I shall take leave to doubt the existence of these 34-ribbed steeds.

"I am afraid I have troubled you with a very long letter, which does not come to much in the way of certainty after all. . . .

"I remain, yours very truly, T. H. HUXLEY."

I have little doubt that Prof. Huxley has solved the riddle. It is open to translate either the thirty-four, or thirty-four ribs; but, whether we adopt the one or the other rendering, it seems clear that the poet must have had some reason for mentioning that number. If thirty-four was the usual number of a horse's ribs in his time, then there seems little reason for giving the number. "Cut the ribs" would have conveyed the same meaning as "cut the thirty-four ribs." If, on the contrary, the number thirty-four was mentioned because it was exceptional, then the poet, and his commentators too, would have said more about the anomaly. Every thing becomes intelligible if we admit that, in cutting open the horse, two ribs were not to be cut, so that they might remain and keep the carcass together. In that case to mention the number of ribs that were to be cut had a purpose, though it is strange that tradition, which in India possesses such extraordinary tenacity in unimportant matters, should not have preserved the original purport of the words of Dîrghatamas. I have looked in vain for a passage where the cutting of the thirty-four ribs in the horse-sacrifice is more fully described; but I ought to add that in the oldest descriptions of the sacrifice of other animals, preserved in the Aitareya-Brâhmaṇa and the Śrauta-Sûtras of Âlvaṛayana, nothing it said of leaving two ribs undivided. "Twenty-six are his ribs," we read: "let him take them out in order; let him not spoil any limb." —*Academy.*

## GEOGRAPHICAL WORK OF 1874.

AT the meeting of the American Geographical Society, held February 25, 1875, the annual address was delivered by Chief-Justice Daly, the President of the Society. Beginning with a brief survey of the remarkable physical phenomena of the year, including great falls of rain and snow, extreme and widely-distributed cold, earth-

quakes, volcanic disturbances, floods, cyclones, etc., he alluded, in passing, to the geography of the sea-bottom as made known by the recent examinations of the Challenger Expedition, and then took up the geographical work in our own country, as carried on by the United States Engineer Corps, and other explorers. The explorations of Lieutenant Wheeler show that every State and Territory west of the Plains is crowded with the products of volcanic action, ancient and modern, the connected beds of lava in Arizona and New Mexico covering an area of 20,000 square miles; and the conclusions of the geologists of the expedition are, that volcanic disturbances and eruptions in our Western territory will be resumed, and may occur at any day. They have occurred so recently, geologically speaking, that it is extraordinary there is no human record of them. In the Department of the Platte, a new route to the Yellowstone Park has been discovered by Captain Jones's exploring party. The Black Hills country was penetrated by General Custer's military expedition, and explored by Captain Ludlow. Prof. Hayden's geographical survey has confirmed the discovery of 1872, that Colorado is the great centre of elevation in the United States, having fifty peaks that are about 14,000 feet high. In the Pacific Ocean, soundings have been made for ascertaining a practicable route for a telegraph cable between Japan and Puget Sound, and for one from San Francisco to the Hawaiian Islands.

The separate researches and explorations of M. Pinvart and Mr. W. H. Dall, in Alaska and the Aleutian Islands, were next reviewed. M. Pinvart is of the opinion that the Esquimaux of this region are of the same stock as those of Greenland and Baffin's Bay, and concludes from their legends and traditions that they came originally from Asia across Behring's Straits. The probability of this conclusion is doubted by Mr. Dall; moreover, many American ethnologists think that Greenland and vicinity were peopled from Europe.

Prof. J. W. Putnam, of Salem, Mass., has been engaged in researches respecting the ancient inhabitants of North America. He believes that the southern Indians (the Mound-Builders of Ohio, Indiana, and other parts of the West) were not connected with the northern or eastern tribes, but were of the same stock as the ancient inhabitants of Mexico, though diversified by immigration and by mixing with other races.

In Central and South America specialists have carried on explorations in Costa Rica, Nicaragua, and the lower part of South America. A French expedition has been exploring Tierra del Fuego.

The arctic event of the year has been the return of the officers and crew of the Tegethof, of the Austrian expedition, and the important discoveries made by them. This expedition, in the difficulties it encountered, the perseverance displayed, the discipline maintained, and the success achieved, is about as heroic as any thing that has occurred

in the history of arctic exploration. The ship was frozen in off the coast of Nova Zembla from August till October, 1872, when the ice broke up, and they found themselves fixed upon an ice-floe helplessly *drifting*, but, strangely enough, to the *northward*. Drifting fourteen months in this way, mere passengers on an ice-floe, they were at last driven ashore and frozen in on a coast which they had discovered, but were unable to reach, two months before. This was in 79° 43′ north latitude, and 60° 23′ east longitude. It was now November, 1873, and they had passed the eightieth parallel. The long polar winter of 175 days set in, and the cold was so severe that the quicksilver remained frozen for weeks, and the darkness in midwinter was intense. The land, to which they gave the name of Franz-Joseph Land, was a most desolate region. In April, 1874, they set out in sledges and reached 81° 57′ north latitude, coming upon a country which they called Crown-Prince Land, whose cliffs were covered with thousands of ducks and auks; seals lay upon the ice, and there were traces of bears, hares, and foxes. Here, over a sea comparatively free from ice, they saw land in the distance, which seemed to stretch beyond the eighty-third parallel of north latitude. Their return-journey was one of over three months' hardship, make in sledges and boats.

In Europe, the long-projected measurement of an arc of the meridian was begun last autumn.

Archæological researches have been prosecuted in Dr. Schliemann's excavations of ancient Troy; and, while many doubt its identity, M. Emile Burnouf, Mr. Gladstone, the late premier, Prof. Keller, of Freiberg, and other eminent scholars, are of the opinion that it is really the city of Priam that has been discovered. But whether the site be Troy, or not, in the twenty thousand objects unearthed we have records which carry us back to the childhood of the world. The excavations in Pompeii show that only a small part of the city has as yet been opened. Every extension adds new objects, none of which are of more interest than its paintings; without these we would have been unable to judge of the excellence to which the Greeks had arrived in the art of painting; for, while their architecture and sculpture have endured, the paintings of their great masters have perished. In Rome, the excavations have disclosed many objects connected with ancient Roman life, public and private. In the tomb of a priest, the gold threads that were woven into his robe remained when every thing else had crumbled into dust.

An ancient Egyptian medical treatise has been discovered by Prof. Ebers, of Leipsic, which, by a calendar on the back of the papyrus, discloses that it was written 1,600 years before Christ.

In Asia, the geographical explorations and researches have, during the year, been numerous and widely distributed. The Sea of Aral has been surveyed, and found to be 165 feet above the level of the ocean, and 250 feet above the Caspian. The river Oxus, which empties into

it, has also been explored, revealing the fact that the country drained by the old river, whose channel is now dry, was the seat of an extensive civilization, of which nothing now remains but the ruins. Explorations have been made in the Himalaya Mountains, with a view to a railroad across Asia. The river Han-kiang, in China, hitherto almost unknown, has been found to be of great commercial importance. For the last four years the rich and prosperous country around Tien-Tsin, in China, has been lying under water from inundations to a depth of nearly five feet, and the unfortunate inhabitants of this once fertile region have been driven to seek new homes in the waste country north of the Great Wall. Many unknown regions have been visited by travelers and explorers, who found new countries, peoples, and customs. In the Kassia tribes, between Siam and Burmah, the doctrine of woman's rights is fully carried out. The women own the land, live in their own houses, do the courting, marrying, divorcing, and the lion's share of work; the men, being the weaker half, and not responsible for the maintenance of the family, do comparatively nothing, and take life easy!

A savage tribe, the remnant of a very ancient people, has been visited on the western coast of India. They are remarkable for their unswerving truthfulness. The women wear over their usual garment an apron of green leaves, the relic of an ancient custom, suggesting a passage in Genesis. In the central provinces the site of an ancient city has been discovered buried in dense jungles, and bearing inscriptions of two and a half centuries before Christ. The inscriptions are chiefly the records of donors of columns, like those seen in the gift-windows of our own churches.

In Palestine, Lieutenant Conder, R. E., has made important discoveries of ruins in the hill-country of Judah, which he thinks he can identify with some of the lost Biblical cities. He has found lost boundary-stones, which may prove to be the ancient Levitical landmarks. Discoveries have also been made upon Mount Zion.

At the mouth of the Persian Gulf there is a small island, of about twelve miles in circumference, called Ormus, or Hormus. Though a barren rock, it became, in the sixteenth century, from its geographical position, a place of great commercial importance and wealth, where the trade between Europe and the East was transacted. A town arose three miles in length along the coast and two miles in width. The Abbé Raynal describes it as presenting a more splendid appearance than any city in the East, and, he says, unusual opulence, an extensive commerce, the politeness of the men, and the attraction of the women, made it the seat of pleasure as well as trade. Milton refers to it in "Paradise Lost," where he describes Satan in council. Last year, Lieutenant Stiffo, of the British Navy, visited Ormus, and found that even its building-materials had been carried away, and that nothing remained of the once great and opulent city but a ruined minaret

about seventy feet high, mounds strewed with broken pottery, and a vast number of water-cisterns now choked with earth.

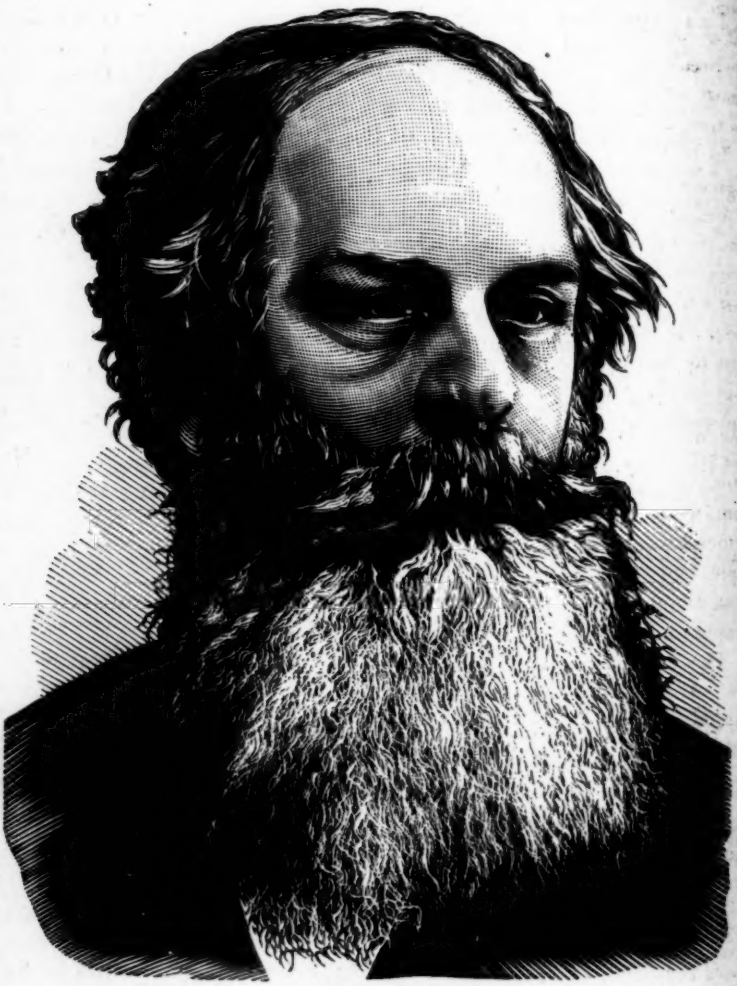
In Africa, Lieutenant Cameron, of the Livingstone Relief Expedition, has made an important discovery which fixes the source of the Nile within known limits, and which, there is every reason to think, will connect the net-work of lakes and rivers of the water-system that Livingstone was investigating, with the great rivers that flow to the western coast of Africa, and probably with the Congo. Livingstone and Stanley had settled the fact of Lake Tanganyika's being connected with Lake Albert N'yanza on the north by a river flowing into Tanganyika. The natives informed them that a river flowed out of Tanganyika at its southern extremity, which, if true, showed that Lake Tanganyika had no connection with the Nile. This outlet Lieutenant Cameron has found on the western side of the lake, about a third of the way up its length. He went into the river about five miles, when his boat was stopped by grass and rushes. The natives informed him that this river flowed into the Lualaba, the river that Livingstone had been following up when Stanley found him. From information got from the natives, Lieutenant Cameron believes that the Lualaba is connected with the Congo, and has started to ascertain the fact. If he should be successful, and return through the Congo to the western coast, it will be one of the most important geographical achievements ever accomplished in Africa. He ascertained the elevation of Lake Tanganyika to be 2,710 feet above the sea. Dr. Nachtigal has returned from an exploration of five years in Central and Eastern Soudan. He says the curse of the country he traversed is the internal slave-trade. It has depopulated large tracts, and the wretched fugitives are now driven to sell each other as a means of subsistence. He saw a caravan of 1,000 of these unhappy wretches chained, while they were driven to the distant market of Kuka on Lake Tchad, the drivers mercilessly cutting the throats of those who were, even under the lash, unable, from exhaustion, to continue their terrible march. The Libyan Desert has been explored and found to be the most sterile part of the Sahara, being a dried-up basin of a shallow sea below the level of the Mediterranean, the present surface of which was found to be a dry chalk plateau, like the Swabian Alps. A French expedition is making preliminary investigations as to the feasibility of M. Lesseps's project for creating an inland sea south of Tunis. The project is opposed by many familiar with this part of Africa, not only as useless, but it would have an injurious effect on the climate of the south of Europe, and also destroy the great source of wealth in this part of Africa, the cultivation of the date-tree. The existing commerce can be sufficiently carried on by caravans, so that the commercial results of the undertaking would never justify the enormous expenditure, which is estimated at £24,000,000. Along the western coast of Africa, explorations have been unusually active. Dr. Güssfeldt made a journey up

the Quilla River, and found a country reminding him of Switzerland. The west coast expedition for the relief of Dr. Livingstone give an interesting account of the region traversed. They found the natives civilized but indolent, and their attention was being given to the cultivation of the India-rubber tree, of the value of which the natives were previously ignorant. On the east coast Mr. Stanley has organized an expedition from Zanzibar at the joint expense of the *New York Herald* and the *London Telegraph*, to explore the region last visited by Dr. Livingstone. The French Marine and the Geographical Society will also send an expedition in the same direction. In Australasia, Prof. J. B. Steere, of the Michigan University, has, during a seven months' exploration in Formosa, gathered much valuable information respecting the island and its people. Interesting explorations have been made around New Guinea by H. M. S. Basilisk, and in Australia several remarkable journeys have been made across the country, through dreary regions and among natives in the lowest scale of humanity. A census of the island of Ceylon has been taken for the first time, and found to be 2,500,000; and in the course of the year the Feejee Islands, 312 in number, and covering an area of 8,034 square miles, have been annexed to the kingdom of Great Britain. The world is fully awake to the importance of geographical inquiry, and its thirty-five geographical societies watch the progress of the lonely traveler and self-sacrificing missionary, estimating their labor at its value, and welcoming every addition they make to the stock of human knowledge.

## WOOD'S DISCOVERIES AT EPHESUS.

EPHESUS, one of the twelve Ionian cities of Asia Minor, was famous in antiquity as containing one of the seven wonders of the world, the great temple of Artemis, or Diana. From very early times Ephesus was a sacred city; the fable ascribed its foundation to the Amazons, and the Amazonian legend is connected with Artemis. The first Ionian colonists in Lydia found the worship of the goddess already established here in a primitive temple, which was soon superseded by a magnificent structure. This Grecian temple was seven times restored, at the expense of all the Greek communities in Asia Minor. In the year 356 B. C. it was burned to the ground, but again rebuilt in a style of far greater splendor than before, the work extending over 200 years. This later temple was 425 feet long and 220 feet wide. "The foundations were sunk deep in marshy ground, as a precaution against earthquake," says Pliny. There were two rows of columns at the sides, but the front and back porticoes consisted of eight rows of columns, placed four deep. Outside, at the entrance

to the temple, stood a basin of porphyry, 15 feet in diameter, for the worshipers to lave and purify themselves in. The internal decoration was of the most sumptuous kind. The cedar roof was supported on pillars of jasper; the doors were of cypress. The altar was the work of Praxiteles, and it was surrounded by many statues, one



J. T. WOOD,
Fellow of the Royal Institute of British Architects.

of them of gold. The image of the goddess herself was roughly hewed out of wood, black with age, and greasy with the oil with which it was customary to anoint it. When the apostle Paul visited Ephesus in the middle of the first century, the worship of Diana still

flourished there, and the temple retained all its original splendor. Pilgrims to the venerated abode of the goddess used to buy little models of the temple in silver, or precious stones, as mementos of their visit, and as amulets to insure to them the protection of the Ephesian Diana. The Goths sacked the city and burned the temple, about 200 years later, and in the reign of Theodosius I., toward the end of the fourth century, the furious zeal of the Iconoclasts, or Image-breakers, completed the work of destruction. The ancient city almost entirely disappeared before the modern era, the very site of the temple being lost.

In 1863 an Englishman, Mr. J. T. Wood, while engaged as a civil-engineer in constructing a railway from Smyrna to Aidin, discovered at Ayasalouk the ruins of the Odeum, or Lyric Theatre of Ephesus, and this circumstance led him to commence excavations in that locality in search of the temple of Diana. He began his excavations on the west side of the ancient city, at a point where a long rise of ground above the level of the plain seemed to cover the portico of the temple. Here he found nothing but the remains of a Roman monument; so he went on digging trial-holes in every direction on the west side, and explored the great Gymnasium, which proved to be a Roman building, erected on the site of a former Grecian structure of similar character. On the surface of the ground, in the vicinity of this Gymnasium, were the remains of some columns of Egyptian silex. At some former time seven of these columns were carried away to Constantinople, and there set up in the church of Saint Sophia, now the Great Mosque. Hitherto they have been regarded as columns from the temple at Ephesus, but erroneously.

The plain has been filled up to the average height of about 15 feet. Digging in the agora, forum, or market-place of the ancient city, Mr. Wood found what he calls a baptismal font, the diameter of which is 15 feet. Its basin is 15 inches deep, and in the centre is an elevated pedestal, on which the minister of baptism might stand dry-shod, the postulants standing in the water. Other monuments of Christian antiquity were also discovered.

But there was yet no sign of the temple, and the literary remains of antiquity gave no indication as to its site. His private funds being now exhausted, the trustees of the British Museum were applied to by Mr. Wood for the means necessary to carry on the work of exploring the Odeum, or Lyric Theatre, in the hope of finding there some bas-relief, or other monument, or at least some idle scratching of a rough artist of the time, which might give some indication of the site of the great temple. In this hope he was encouraged by what he had years before seen in Venice and other places, viz., the plans of cities cut in bas-relief upon the pinnacles of the churches. The trustees of the British Museum having made the required grant of funds, Mr. Wood began the exploration of the Odeum. He found his way

into this theatre through the central doorway, and, on clearing the *pulpitum*, or stage, discovered on the pavement many small fragments of marble. These, on being put together, were discovered to contain inscriptions in Greek; they were the text of three letters of Antoninus Pius to the people of Ephesus, two dated A. D. 145, and one dated five years later. This theatre was 153 feet in diameter, and could seat 2,300 persons. Near it were found the remains of a tomb, which Mr. Wood takes to be that of the evangelist Luke; it was apparently a circular building, 50 feet in diameter, standing in a quadrangle 150 feet across, surrounded by a colonnade.

The exploration of the Great Theatre or amphitheatre began in February, 1866. This was one of the largest structures of its kind in Asia Minor, being 495 feet in diameter, and capable of seating 24,500 persons. Here were found many interesting Greek, and a few Latin inscriptions—chiefly decrees of the senate and people of Rome—and also some sculptures. One of these inscriptions, known as the Salutarian inscription, furnished to the persevering explorer the clew to the site of the temple. The inscription consisted of decrees relating to gold and silver images vowed to Diana by C. Vibius Salutarius. It is there prescribed that on certain days of assembly in the theatre these images were to be carried in procession by a priest of the temple, accompanied by a staff-bearer; and after the assembly they were to be carried back to the temple. Here was the desired clew to the site of the temple. "There were," says Mr. Wood, "two gates to the temple, named the Magnesian and the Coressian gates. It seemed to me that if I could find these gates their direction could not fail to point to the site of the temple. I at once searched for them, and in due time they were found."

In January, 1868, he put a gang of seventy men to work at the great theatre, and at the same time began to follow up the road leading from the Magnesian gate. This consisted of three openings—two for foot-passengers, and one for wagons and chariots. The pavement was intact, with four distinct chariot-ruts cut into it. Having followed up this road for about 700 feet, Mr. Wood came upon the stone piers of a portico 12 feet wide. This was undoubtedly the grand portico built by Damianus, a rich Roman noble. Many tombs were found, some of which were vaulted chambers finished in stucco or cement, and painted, and these had tablets over them. In some of the tombs were found several skeletons—in one as many as fourteen—lying in various directions. Next he hit upon a corner of the Peribolus wall, on which were inscriptions showing that this wall was built in the time of Augustus.

This was in May, 1869. The discovery of the Peribolus wall proved sufficient to induce the trustees of the British Museum to make further advances of money, and accordingly work was resumed in the October following. In the area within this wall, i. e., in the

sacred precinct of the temple, Mr. Wood sank a great number of trial-holes. Nothing of interest was discovered until the explorer had proceeded about half a mile from the angle first discovered, and then remains of Roman buildings began to be found. Soon he came to a long line of Roman buildings which must have been the dwellings of the priests and priestesses of Diana. He continued the explorations, searching for a similar range of buildings opposite, but found only one small building—a Roman temple. As this was not the Temple of Diana, he next began a search of the space between the buildings. This was found to be an open space, and the explorer conceived the idea that the temple must be in the rear of it; but in the mean time he found another building, and finally in the very last day of the year 1869 he hit upon the pavement of the temple itself, more than twenty feet underground. The main difficulties of the work were over: it was now a question simply of expense. The pavement was all beautiful marble. It was in two layers: the upper course in white marble, the lower one in cement, making altogether a thickness of two feet. At this stage the village of Ayasalouk was flooded by heavy rains, and the excavations were completely filled up with sand and water. When the water had subsided operations were resumed, and by October, 1870, there had been unearthed half a dozen of the large columns of the temple and fragments of one of the capitals, which had fallen over. One fallen column he traced to its base, and there ascertained that the same base had been employed in supporting columns in the last three temples. First of all we have the stone of the temple which was commenced 500 B. C.; this was used as the foundation of the column of the last two temples, one rising above the other.

In January, 1871, Mr. Wood bought the land over the temple for £160, and in less than a month afterward found, five feet beneath the surface, 2,600 coins of the fourteenth century, amounting in value to many times the price paid for the land. The British Government, in 1872, made a grant of £5,000 for the prosecution of the work, and another of £6,000 in the following year.

The discoveries on the site of the temple in the season of 1872–'73 comprised two large fragments of the frieze with human figures, life-size, in high relief, and the figure of a stag; the base of one of the inner columns of the peristyle; two sculptured drums of columns; some lions' heads, from the tympanum at the west end of the temple; a large fragment of a cedar beam from the roof, and a number of fragments from the last three temples. Numbers of Arabs came and pitched their tents near the excavations, and all the able-bodied men were employed on the works. The explorer's wife was of great service in caring for the health of these laborers and their families; sometimes she had as many as sixty patients under her care, without any doctor nearer than Smyrna.

Work was suspended in May, 1873, and resumed in October. During the season of 1873–'74, Mr. Wood made discoveries which enabled him to complete his plan of the temple. More than 100 feet of of the lowest steps of the platform were found in position in different parts; also a sculptured drum, with draped figures alternately seated and erect. At the beginning of 1874, Mr. Wood, having only a small balance on hand, applied to the trustees of the British Museum. He was allowed only a small sum, with instructions to close the work when it was expended. He therefore began to remove the cella walls, and found distinct remains of the last three temples. Part of the pavement of the temple destroyed by Erostratus was found in position, and also the altar at the east end of the *cella*, or shrine, which must have served for the three temples; also about 200 fragments of sculpture and architectural enrichment, of which the piers had been composed. Some of the sculpture was archaic. As Mr. Wood found several lime-kilns on the site of the temple, and large heaps of marble chippings ready for burning, we know what became of the works of Praxiteles, Scopas, and others.

On extending the excavation thirty feet beyond the lowest step of the platform a wide portico was found, which must have surrounded the temple on three sides, and also the remains of a Grecian Doric building, which could not be explored for want of funds. We have already stated that the foundations of the temple were laid in marshy ground, and Pliny says that this ground was prepared for receiving the foundation by having laid down upon it a layer first of charcoal, and then of *wool!* Mr. Wood makes no mention of this absurd statement of Pliny's, but says that, according to the usual account of the building of the temple, there was first laid a solid foundation of stone, and that upon this were laid charcoal and pieces of wood. To clear up the question, he made very careful excavations near the walls of the temple and underneath the wall, and found first of all a layer four inches thick, of a putty-like substance, very similar to glaziers' putty, both in constitution and appearance. Underneath this there was a layer of charcoal three inches thick. Then came a layer of putty four inches thick, making in all eleven inches, and upon this the walls of the temple rest.

# CORRESPONDENCE.

## CONSERVATION OF FORCE.

*To the Editor of the Popular Science Monthly:*

WILL you allow me to call the attention of scientists to some facts (suggested by me in the MONTHLY for February) inconsistent with the most important recent theory in physical science—the Conservation or Persistence of Force.

The persistence of force is as certain as the persistence of existence. But persistence being, so far, an absolute property or principle, cannot be proved by physical sense, or phenomena conditioned by mass, time, and space. Only finite relations are verified by finite proofs.

All things perceived through physical sense are, severally, quantitatively, and qualitatively, in unceasing change, and are, directly or indirectly, dependent on each other for their existence. Therefore, not phenomena, but only principles—things *per se*—persist. That the force or energy which we perceive, pressure, tension, or motion, does not persist, is not only a logical deduction from the nature of phenomena, but is a familiar fact in our experiences.

Force—pressure or tension—is created and annihilated at pleasure by the use of the lever.

Energy is evoked from motion, and motion is only changing relations in space, and as each specific or perceived change or movement is absolutely created and annihilated, not the *perceived* energy, but only the ideal, abstract principle, persists.

Again, the conservation of perceived force requires the existence of potential energy, or energy of position. But this "energy" is a misnomer; for mere position, or static relation in space, is in itself important, and therefore answers our conceptions of neither energy nor potentiality. Yet, it is alleged that the energy expended in lifting and planting a mass on the top of a mountain persists in the mass, because, *if it could fall*, that same energy would reappear. But it cannot fall. And its gravity being less, it has within itself, as a property, less falling force than before its position was changed by the expenditure of energy. To say, "If it had power to fall, it would *receive* the energy expended in lifting it," is equivalent to saying, "It does not possess that energy." If it imparted that energy to something else, from which it will be returned, to what did it impart it? If the ball in a loaded cannon has potential energy by being in front of the cartridge, what becomes of that energy when the powder is saturated with water?

Perceived force is conditioned by mass and relations in space, and, as here shown, change in these conditions changes its quantity. Physical science is limited to these conditions, changes, and quantities, because its verifications are limited to them. The proposition that a phenomenon persists, is a self-contradiction. Only objects of conception, and not of perception, persist.

The conservation of force is illustrated by that of form. If a circle of plastic material be changed to a square, abstract form persists through all the innumerable changes of size and form through which it passes, but no observed size or form persists; *nor is any specific form, from the circle to the square, metamorphosed into its subsequent form;* each is as absolutely created and annihilated as though there were no persistence of form.

And, as matter is only a concrete of properties, and as form is as persistent as other properties, it follows that all perceived physical changes are creations and annihilations. What is observed as gas is not the persistent thing *per se*, but only one evanescent state of that which persists. Hence, this perceived thing, gas, is no more metamorphosed into its subsequent water, than a circle is into a square. All that was observed—gas—was as totally annihilated, and what appeared—water—as surely created, as were the circle and square. No perceived physical property persists, for, even the alleged physical proof of the per-

sistence of matter—weight—is annihilated and created by distance and proximity to the earth.

Physical science relates only to the limited and conditioned, because its proofs are limited. The unlimited—persistent—is beyond the realm of physical sense and experimental proof. Hence, only abstract, ideal force persists, and is known to persist, not from our experiences with perceived forces, but only because mind, heredity, and mental experiences, evolve the conception of ultimate, absolute principles, and forbid the conception of their annihilation.

Proper discrimination, exactly expressed, between perceptions of the finite and conditioned, and conceptions of the persistent and absolute, rids science from the odium of materialism, and other fallacies, and makes the persistence of force not a new theory, but what it was ever conceived to be—the principle of potency—causality—an attribute of the ever-existing I AM.

Alleged infallibility of spectrum analysis of suns and nebulæ, billions of miles distant, when, for terrestrial use, the Director of the United States Mint says, "it cannot be trusted," shows the present tendency to sacrifice logical mental conceptions to mere physical sense.

Religious superstitions, in their conflict with science, will not succumb to sophistry: but, let scientific, physical facts be fortified with careful experimental verification, and hypotheses with pure logic, and give mind, though it be "discerned in matter," its fair share of the universe, and both superstitious bigotry and fallacious dogmas will surely disappear.

A. ARNOLD.

TENAFLY, N. J., *February* 20, 1875.

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## EDITOR'S TABLE.

### *DRAPER AND HIS CRITICS.*

DR. DRAPER has reason for gratitude to his friends, and doubly so to his enemies. He wrote a bold book upon a subject never before separately treated, and by a large portion of the press it has been received with favor as a valuable and important contribution to the serious thought of the time. The interest in the subject, the reputation of its author, and the cordial commendation of many critics, were certain to secure the work a fair measure of success; but, on the other hand, a considerable number of writers were enraged by it, and, with the usual folly of passion, have execrated it into about thrice the circulation that it would otherwise have had. It is to be hoped they will learn that things are often overruled, in this world, to ends not contemplated by their contrivers. This, however, lends no excuse to bad practices, and those who have unscrupulously attacked Dr. Draper's work are to be held to account for it, just the same as if they had not overreached themselves in the result aimed at.

The honest and intelligent criticism of his book will, no doubt, be respected by its author, and objections to its reasonings and conclusions will probably be taken into careful consideration; while, if convinced of their validity, he may be expected to indicate it in future editions of the volume. But by a very considerable portion of the religious press, and by many secular journals, the editors of which know where to flatter and where to abuse, with a view to brisk sales, the book has been vehemently denounced. *Scribner's Monthly*, for example, published in March an admirable article on the "Indecencies of Criticism," and the same number contained a "criticism" of Dr. Draper's work, illustrating them so perfectly as to raise the suspicion that such was its design. The frothy invective that has been copiously poured out under the name of criticism is, of course, not worth noticing; nor shall we trouble ourselves with the various petty objec-

tions that have been raised, and that are so easy to raise, against a work of this character. But one criticism, particularly, deserves attention, because it lies against the whole reason and purpose of the book, and has been made on all sides; in fact, it forms the only unanimous basis of attack on the part of Dr. Draper's assailants. It is said that his work is a fiction, and represents no reality; that his subject is an illusion, his title a misnomer, and his book a mere figment of the imagination. He professes, it is said, to write a "History of the Conflict between Religion and Science," when there is not, and never has been, any such real conflict, and therefore no possibility of its history. The organs of all the orthodox denominations are in emphatic accord upon this point, and even the outside sects—Jews, Unitarians, and Catholics, whom the orthodox repudiate as beyond the pale of Christianity, as knowing nothing of true religion—take precisely the same ground in regard to Dr. Draper's work. The *Jewish Times*, for example, says: "Is there really a conflict between science and religion? We answer emphatically, no! There is no such conflict! there can be no such conflict!" Dr. Thomas Hill, in the *Unitarian Review*, says of Draper's book, that "so far from giving us a history of the conflict between science and religion, it gives us nothing to show that such a conflict ever existed;" and Dr. Brownson, at the Roman Catholic extreme, declares of our author's volume, "He professes to give in it the history of the conflict between religion and science, or of a conflict that has never occurred, and never can occur." There is, at all events, little conflict here, but an harmonious strain of denial of the legitimacy of Dr. Draper's subject, all along the line, and which reaches even to the dubious borders of that which is recognized as no religion at all.

What, now, are we to make of this? It can hardly be that these diverse parties have solemnly conspired to perpetrate a huge joke; and we can only suppose that they are serious at the expense of their intelligence. Religion and science have certainly coexisted in the world for a long time, and they have both figured pretty largely in human thought and human affairs. They must have had some relations with each other, and these relations must have had a definite character. If they have not been in conflict, then they have been out of conflict, or in harmony. Those who deny the antagonism must affirm the opposite, or that the relations of religion and science are, and always have been, those of concord and harmony. But, if this be so, let it be understood that Dr. Draper's work is not the only one that is discredited. What means the multitude of books that have been written professedly to bring these subjects into harmony? There is a vast body of theological literature, going back for centuries, that is devoted to the work of *reconciling* religion and science. Whole libraries of such literature have been consecrated to the harmonization of separate and special phases of that relation. Generation after generation have spent a large part of their theological force in reconciling Christian doctrine which has been held as religion, with astronomical, geological, biological, and ethnological science. If Dr. Draper is a romancer, then all this must also go to the account of romance. If there has been no conflict, then there could be no reconciliation, for the attempt to reconcile that which is already harmonious is absurd. If it be said that our ignorant predecessors may have fancied a hostility which we now know to be unreal, the reply is, that the work of reconciliation was never so rife as to-day. We could run THE POPULAR SCIENCE MONTHLY alone on the papers we receive from the theological side, aiming to harmonize present religious thought with the

present condition of science. Why this vigorous and comprehensive effort to harmonize the already harmonious? The religious periodicals abound in discussions aiming to compose the alleged differences and discords of religion and science; and there pours from the press a continuous stream of books devoted to the same end. An impending volume of eight hundred pages is announced by a correspondent of the *Evening Post*, who gives an analysis of its contents, and remarks: "The conflict between science and religion as to man's origin on this planet has been so ardent, and the interest which men of culture the world over feel in the subject is so deep and growing, that I can hardly be mistaken in supposing that the readers of the *Evening Post* will be pleased to receive a synopsis of Mr. Southall's book, the proof-sheets of which I have been kindly permitted to examine. He combats the views of Lyell, Lubbock, Evans, Lartet, De Mortillet, Nillson, Worsaae, Désor, and others, that man is several hundred thousand years old, or, as Mr. Geikie and Mr. Boyd Dawkins, in their recent books put it, preglacial." Again: "The book will provoke a deal of criticism in scientific and religious circles. Persons far more competent than the present writer to pronounce judgment upon its merits, do not hesitate to say that it is the most important contribution yet made in America to the theological side of this weighty subject." Of course, "the theological side," which holds that there is no such thing as "the conflict between science and religion," "ardent" or otherwise, will at once proceed to squelch this superfluous writer; and when they have done so, and repudiated the folly and futility of all other books of the same class, and dried up the discussion in their periodicals, it will be time to talk to Dr. Draper about the illusiveness of the subject-matter of his history. There is something not a little ludicrous in the attitude of those who are lustily continuing a fight that is centuries old, and, when the history of it comes to be written, suddenly turn non-resistants, and protest that it is all a mistake, and that there has really never been any conflict at all! Can it be that it is because they would rather not have the history appear?

But it will be said that truth can never be in conflict with itself; that religious truth and scientific truth *must* harmonize, and that any apparent antagonism is due to prejudice and imperfect knowledge. Granted; but this concedes the fact of a conflict, and only proposes a theory of its cause. The harmony affirmed is not a harmony realized, but rather hoped for, as a possibility of the future, to which present broad and thorough investigation is tending; and with this we entirely agree. But the hope of a state of things yet to be reached cannot be made a ground of denial of what is, and has been. It is maintained that, at bottom, there is no real conflict between capital and labor, and many indulge the anticipation that their relations will be ultimately harmonized; but he who denies that there is now any such conflict had better spend a few days in the mining districts of Pennsylvania, where for months this conflict has threatened the peace of society. It is also held that the true and highest interest of nations is that of concord, and many think that the world will yet grow into international amity and unity; but shall we therefore deny the past existence of war, and discredit as groundless all our histories of international hostility? The case of religion and science is exactly parallel. However they may finally be brought into accord, they certainly are not in that relation now, and no antagonism of the past has been more deep and unrelenting, and more defiant of all efforts at adjustment, than this. The conflict between religion and science,

or between the study of Nature and the tracing out of its order, and the systems of belief that claim a religious character, is as much a reality of human experience as the collisions of nations, and just as much a proper subject for the historian.

Dr. Draper has been much reproached for not defining what he means by religion. There is no complaint that he has not defined science, because no need of it is felt; everybody understands what science is. But it is not so with religion. The theological world is full of dispute and contention as to what religion is. It is loudly declared by the theological party that science and religion are in harmony, and then the theological groups fall straightway to battling over the initial question as to what constitutes religion! Each group assumes it to be what its members believe, and what those with different beliefs do not possess. The reverend representative of the Unitarians, Dr. Hill, says of the oldest and most numerous Christian communion: "The hostility of this corrupted Church toward science was no greater than its hostility to religion; religion and science, twin forms of truth, were alike persecuted by this dragon; and it is both an injury and insult to Religion to ascribe to her the evil deeds of those who hate her, and wore her name simply as a cloak for their political ambition and their intolerant pride. For every martyr of science, history can show a thousand martyrs of religion slain by the ecclesiastical powers of Rome." But the representative of the "dragon," at the opposite wing, is ready with his reply to this Unitarian Gentile. Dr. Brownson says: "Christianity teaches that Gentilism is apostacy from God and from his truth, and that so far from being his worship it is the worship of devils. We protest, therefore, against the logic that concludes that what it finds true of Gentilism is and must be true of Christianity. We protest also against concluding that, because Protestantism is a congeries of absurdities, Catholicity is unreasonable and false. Gentilism and Protestantism may stand in the same category or be simply varieties of the same species; but they are specifically, generically different from Christianity." And between these two extremes there is a crowd of sects which agree in little else than in dismissing the Catholics and Unitarians to perdition as destitute of all religion! Dr. Draper, it is evident, would have complicated his case to little purpose had he gone into definitions, and thus virtually assumed to decide, among these conflicting claimants, which has the true religion. For historical purposes Dr. Draper was compelled to take broad views, and to recognize as religious all bodies of people who combine and organize for religious ends, profess religious faith, and make claims to religious character, giving prominence in his treatment of the subject to those who have been historically most prominent, and are most responsible for theological resistance to the reception of scientific ideas.

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### *WITH REFERENCE TO SPELLING.*

The severity of the spelling-school contagion is manifestly abating. This is well, for we are told that public excitements are dangerous to reason, intense and prolonged spasms, religious or social, generally ending in a new accession of recruits for the lunatic asylum. It is an interesting question what degree of fervor, extent, and duration of spelling-matches would be required to reduce the general mind to a condition of imbecility. Life is full of contradictions, and we can rarely go a mile with our logic: to misspell our language is a sin, while to reach the height of orthographic virtue may involve intellectual suicide.

We recollect a wave of excitement

that passed over us a few years ago in relation to spelling, a feature or two of which may be worth recalling. A veteran school-teacher of New York dropped a hurried line to a newspaper, in which two or three words were wrongly spelled. It was a dull season for news and excitement, and so, in its enterprise, journalism sat on this old party, and his life was darkened. He has since gone to that undiscovered country where it is to be hoped that Webster and Worcester have never been heard of; but he has left us struggling with the beggarly elements of a barbarous orthography, and no better off for the storm of reproach to which he was a martyr. His fellow-teachers came to the rescue with indignant letters to the editor, and that remorseless personage published them, bad spelling and all, every time. "Behold," said he, "the state of American education, when its masters are unable to spell their native language!" There seemed no question that the highest achievement of the human mind was to put letters together in exact accordance with some authority; and that to drop or transpose a letter, in the tens of thousands of their arbitrary combinations, that form the words of our language, was an offense that should consign its perpetrator to everlasting ignominy. The thing was all going one way until there arose a rebellious voice in the East, which said to the editor: "Let me take advantage of the present spelling excitement to fatten a grudge I bear against the literary world." The soul that had been thus stirred to utterance was that of Elizur Wright, and he went on, in his pungent way, to say: "A school-master who does not spell correctly by somebody's system should go abroad and stay there. But just here it is that my indignation kindles. Why do we have these illiterate school-masters? I do not stop to blame weak or careless committees: the trouble lies higher. The great masters of English literature, the lawgivers of our language, are such bunglers or charlatans in their own profession, that they ought to be ashamed to fling a pebble at the worst of spellers, or even at the inventor of Egyptian hieroglyphics." After venting his wrath upon the conservators of the present "imperfect, unreasonable, stupid, false plan of visualizing the vocal tongue," he thus proceeds:

"The misery of the matter is, that it is difficult to get any but blockheads to teach such a blockhead system. We do uncommonly well when we get hold of pedantic dunces who can teach spelling with a vengeance, and perhaps the shell of grammar. Of course, I do not deny that there are some literary saints, of unquestionable genius, who devote or doom themselves to a painful inculcation into the memories of reluctant or rebellious youth of all the incongruities, contradictions, riddles, and sphinx-puzzles of English orthography." And again: "English orthography is congenial only with stupidity; and, after thirty or forty years of occasional observation in regard to it, I am of opinion that good and successful teachers of spelling can seldom write a page without misspelling several words."

And this is the writer's significant climax: "Of another thing I have no doubt at all, to wit, that learning to spell is a discipline pernicious to good mental habits. The minds of unschooled children are eager for facts and the reasons of them; and they are not satisfied with a reason till they see its force. But, after they have been schooled through the inconsequential mysteries of the spelling-book, where a reason has less chance of living than a mouse in a vacuum, they are ready to swallow any thing the book or the teacher says, with a leaden quietude. No thanks to the portico of our literature, if they do not continue to take things on trust, as long as there is any thing to be so taken."

There is a truth in these last remarks which deserves from educators a great deal more serious attention than it has yet received. No one will deny that our spelling is irrational; and, if so, just to that degree the art of spelling is an irrational practice; that is, it is a practice which, in the first place, calls for no exercise of the reasoning faculty; and, second, it is an exercise which continually violates the dictates of reason. The pupil who should spell a word as reason dictates would be flogged, or in some other way disgraced before the school. On the other hand, the pupil that can bring his mind into the most perfect harmony with an irrational system, can go on perpetrating absurdities the longest without failing, wins prizes and applause. This certainly cannot conduce to good mental habits. The child is born into a world of real objects and relations, and the mind grows through experience in acquiring ideas of these actual things. Discrimination, comparison, inference, reasoning, judgment, are all elements of early mental activity, and, in fact, constitute the intellect. Mental growth consists essentially in strengthening and extending these operations on newly-acquired and newly-combined ideas. These rudimentary processes of the infantine intellect are of exactly the same nature as the perfected processes of scientific and philosophic intellects; and it is the true office of education to lead them out, or guide their unfolding from lower to higher states. Written language must be called in at an early stage, as an indispensable help in this upward progress. Yet, such is the imperfect character of this new instrument, and such the bungling of many who teach its use, that the child is quite as apt to be hindered and stopped by it, in its mental course, as helped on. Nay, when we remember that this is the most critical stage of mental unfolding—the taking of the child out of Nature, as far as that can be done, and immersing it in the school where irrational mental practices are arbitrarily enforced—it is no exaggeration to say that more mind is extinguished than is led out, and that the school-room is as liable to become a mental slaughter-house of the innocents as a place of healthy education. When a child enters school, there should be no break in its earlier mental unfolding; but this is just what generally occurs. Instead of going on with its normal mental exercises, it is turned off into artificial mental exercises. Instead of still employing its thought mainly upon the properties and relations of things, symbols are substituted for things, and the whole action of the mind becomes a manipulation of symbols. The memory is not only loaded with verbal signs, but these are arbitrary and contradictory; and an accuracy is exacted in retaining them which consumes an immense proportion of the time, and, after working great mental mischief, generally ends in failure. Tolerable spelling is, of course, an important thing, but we do not believe in dwarfing or stupefying the mind to gain it. Let it be taught incidentally, and in subordination to the regular exercise of the higher faculties, and the end will be better served than by trying to make it the prime accomplishment of education. Perhaps, in regard to so fundamental a reform, but little is to be expected from the present generation of teachers; but, happily for the hopes of humanity, there is an arrangement by which the present generation of teachers is destined to be taken out of the way.

## LITERARY NOTICES.

ENGLISH MEN OF SCIENCE; their Nature and Nurture. By FRANCIS GALTON, F. R. S., etc. New York: D. Appleton & Co. London: Macmillan & Co.

THE author of this book is quite widely known by his former publication, "Hereditary Genius," and by various statistical

works. Here he has attempted to analyze the "Natural History of the English Men of Science of the Present Day," and to determine, if possible, the effect of the circumstances in which they have lived, including the consideration of their antecedents, their hereditary qualities, their education, and of the influences which have made them what they are.

His definit.on of a man of science, for the purpose of his inquiry, is characteristically English, although it may be, on the whole, the best attainable one for the special questions of which he treats; he selects, then, only members of the Royal Society of England, and among these he still further separates those who have received a medal for scientific work; those who have presided over a section of the British Association for the Advancement of Science; those who are members of a certain literary and scientific club of London, etc., etc. On these grounds 180 men have been selected, who are presumably representative English scientific men.

The author estimates that at least 300 men could have been selected, and that this gives (having regard to age) about one scientific man to every 10,000 in England.

His question then is, "What are the conditions of nature and the various circumstances and conditions of life—which I include under the general name of nurture—which have selected that *one* and left the remainder?" The data available for the solution of this question are "the autobiographical replies to a very long series of pointed questions addressed severally to the 180 men" previously described. Of course, these replies were given in confidence, and it is not possible for the reader to connect the various replies, which are often given in detail, with any one person interrogated.

The first inquiry is into the "Race and Birthplace" of the subjects of the inquiry. Out of ten scientific men, five are pure English, one pure Scotch, etc.; their birthplaces are usually in towns away from the seacoast. "The branch of science pursued is often in curious disaccord with the surrounding influence of the birthplace. Mechanicians are usually hardy lads, born in the country; biologists are frequently pure townsfolk."

The occupation and position in life of the parents are next considered, and the chief point of interest here developed is that, out of every 100 scientific men, only three or four have had clergymen for their fathers. Although so many of the graduates of the English universities take holy orders as a means of securing fellowships, yet it is noteworthy that, in a fairly-selected list of 660 separate appointments on scientific councils, only sixteen have been divines, and these have chiefly been proficients in the astronomical and mathematical sciences, and not a single biologist is to be found among them. The inquiry proceeds to physical peculiarities of parents, and the conclusion is reached that out of 165 cases examined these peculiarities were in *harmony* seventy-eight times, in *contrast* thirty-one times; from examination of special conditions, such as the height, color of hair, corpulency of the parents, the general result is that the parents of scientific men are decidedly more in harmony as to their physical characteristics than in contrast.

In some of these discussions we confess to a slight feeling of doubt as to the trustworthiness of the conclusions. Although "figures will not lie," there may be an accidental accumulation of coincidences in a small number of cases which will quite mask the real law, and statisticians need excessive care in drawing such conclusions.

In general, this caution is evident throughout the volume. We have given enough to elucidate the author's method; and we will only note those conclusions which seem most interesting, referring the reader to the book itself for details.

The average number of living children of scientific men seems to be, on the whole, decidedly smaller than that of the parents of these men; their health relatively to their parents is not so good; in one out of every three cases their marriages are sterile. In contrast to this, it may be said that their health, relatively to that of the average man, is better and their energy greater. Still the conclusions above noted do not promise well for the continuation of the race as pure blood.

Chapter II. deals with the qualities of the men themselves, as derived from their answers to the questions proposed to them.

Out of every ten, "seven call themselves members of the Churches of England, Scotland, or Ireland," while the remaining three are distributed among various sects; two out of every ten have a "decided religious bias."

To the question "Has the religious creed taught you in your youth had a deterrent effect on the freedom of your researches?" seven or eight say "No" to one who says "Yes."

Chapter III. deals in an admirable manner with the "Origin of the Taste for Science," and we commend it to all who are interested in scientific education; together with Chapter IV., which deals with the merits and demerits of the education itself.

The lessons of these two chapters are condensed by the author into this general statement: *Teach a few congenial and useful things very thoroughly; encourage curiosity concerning as wide a range of subjects as possible; and do not over-teach.* Specially he recommends (from the knowledge gained from his inquiry), for the precise subjects to be studied in order best to educate a youth for scientific pursuits: 1. Mathematics; its processes to be utilized for interesting ends and practical application; 2. Logic; 3. Observation; theory in experiment in at least one branch of science; 4. Accurate drawing of objects connected with this branch; 5. Mechanical manipulation. "These five subjects should be *rigorously* taught." There should remain enough time for literature, history, poetry, and languages: these last are to be learned solely to enable the learners to read ordinary books written in them.

Most of these conclusions are quite as applicable to America as to England, and they deserve the most careful attention.

Roughly speaking, the author finds that "six out of every ten men of science were gifted by nature with a strong taste for it," and "we may therefore conclude that the possession of a strong special taste is a precious capital, and that it is a wicked waste of national power to thwart it ruthlessly by a false system of education." No test can be given to distinguish in the youth a special taste from a passing fancy, but hereditary inclinations should be carefully regarded. A curious result of the inquiry is, that the influence of the father in determining the scientific taste is three times more potent than that of the mother. Probably the general impression on this point is opposed to such a conclusion.

The practical lesson for England is drawn with great force and skill by the author on page 222, *et seq.* Much of this is inapplicable to us in America, but it is in the highest degree valuable generalization, and it is peculiarly worthy the attention of educators.

Science with us is sporadic, and no one is in any degree directly responsible for its fostering, except, perhaps, the larger universities. There is no central power which can assist its prosecution, nor is there much intelligent inclination on the part of our lawmakers to help it or hurt it. As an example of the lack of intelligence in the forwarding of scientific research, we may note the liberal appropriations ($175,000) for the observations of the transit of Venus by the last Congress but one; and the refusal of more than $3,000, by the last Congress, for the preliminary computations incident thereto. Evidently for us at this time the lessons of this book are not to be applied, but much more elementary ones; yet, undoubtedly, the true principles of "government aid to science," and of the "endowment of research," are correctly indicated.

These are questions which assuredly will arise in America as they have in England, and we cannot doubt that the careful analysis here given will serve as a firm basis for rational action in this most important direction.

THE HEART OF AFRICA: Three Years' Travels and Adventures in the Unexplored Regions of Central Africa, from 1868 to 1871. By Dr. GEORG SCHWEINFURTH. In two volumes. Price, $8. Harper & Brothers.

THIS is a model book of travel, fresh, entertaining, full of novelty, yet in a high degree instructive and trustworthy. Its author combines the accomplishments of the artist with the solid acquirements of the man of science and the ardent enthusiasm of the explorer, so that, though still a young man, his name is already famous both in Europe and America. The history of Dr. Schweinfurth happily illustrates the power

of early impressions. At his first school one of the masters was the son of a missionary in South Africa. The stories he told of the wonders of that distant country took possession of the youthful fancy of his pupil, and turned his mind toward the land where he was to achieve such signal renown. Dr. Schweinfurth devoted himself from boyhood to the science of botany. He studied at Heidelberg and Berlin, where he took his degree as doctor of philosophy. In 1860, when about twenty-four years of age, his interest in Africa was intensified by the circumstance that a collection of plants from the region of the Nile was placed in his hands to arrange and describe. While engaged in this work, a yearning came over him to behold these plants in all their bloom and beauty in their native haunts, and so added an immediate stimulus to his life-long interest in that strange country. Accordingly, in 1863 he left Berlin for Egypt, and, after botanizing in the Delta of the Nile, along the shores of the Red Sea, in Abyssinia and Khartoom, for two years and a half, he went back to Europe with an empty purse and a splendid collection of plants, though obtained at the additional cost of repeated attacks of fever. But this expedition only whetted his appetite for African exploration, and he soon submitted to the Royal Academy of Science a plan for the botanical survey of the equatorial districts lying west of the Nile, portions of which were still wholly unknown. His proposals were accepted, and the expenses of the enterprise were met by the "Humboldt Institution of Natural Philosophy and Travels," in Berlin. In July, 1868, he again landed in Egypt, and in the first chapter of this work he records the incidents of his journey till his arrival at Khartoom. After a short delay he proceeded up the White Nile and Gazelle. He says:

"In the early morning of the 22d of February we found ourselves at the Meshera, the landing-place of all who resort to the Gazelle. . . . Deducting the days on which we had not proceeded, our boats had been thirty days in going from Khartoom to the Meshera. I had been anxious to make a good investigation of the river-banks; otherwise the voyage might easily be accomplished in twenty days."

As a result of this study, several pages are devoted to explanations of this river system and the topography of the swampy region of the Meshera, where he was compelled to linger through February and March, botanizing in swamps, wading among papyrus-clumps, and exposed to the dreaded malaria of this unhealthy region. His immunity from sickness he attributes in part to the three doses of quinine, of eight or nine grains each, which he took daily. Half the travelers who have ventured into these swamps have succumbed to fever. Here Miss Tunné's expedition suffered a loss of five out of its nine European members, and among them Dr. Steudner, the botanist of the expedition. Here Heuglin lost most of his time by continual relapses of fever. And in this region Le Saint, a French geographical explorer, had died a few months before. From this place he took his start for the interior. He thus describes his company:

"The number of our caravan was a little under 500. Of these the armed men amounted to nearly 200, and constituted a force with which we might have crossed the largest state of Central Africa unmolested. Our course for six days would be through a notoriously hostile country, so that this precaution was quite necessary; but the caravan, extending fully half a mile, was of a magnitude to require great order and circumspection. . . . To a naturalist on his travels, the employment of men as a means of transport appears the perfection of convenience. Apart from the dispatch and order in starting, and the regular continuous progress, he enjoys the incalculable advantage of being able to reach his baggage at any moment, and to open and close again, without loss of time, any particular package. Any one who has ever experienced the particular annoyances of camel-transport will be aware of the comparative comfort of this mode of proceeding. A few asses accompanied the caravan, and the Governor of Ghattas's Scriba had been courteous enough to send me his own saddle-ass, but I preferred to trust myself to my own legs. Riding a badly-saddled donkey is always infinitely more fatiguing to me than any exertion which may be requisite to keep up with the forced marches of the light-footed Nubians; besides, I had other objects in view than mere progress; I wished to observe and take notes of any thing that came in my way, and to collect plants and whatever else might be of interest. Thus, entirely on foot, I began the wanderings which,

for two years and three months, I pursued over a distance of more than 2,000 miles. Neither camels nor asses, mules nor horses, teams of oxen nor palanquin-bearers, contributed their aid. The only animal available, by the help of which Central Africa could be opened to civilization, is exterminated by fire and sword: the elephant is destroyed mainly for the purpose of procuring for civilized nations an article wherewith to manufacture toys and ornaments, and Europeans still persevere in setting the savages a pernicious example in this respect."

After passing through the lands of the Dinka, Dyoor, Bongo, and Mittoo, and adding much to our knowledge of these people while studying the topography of the country and contributing important discoveries concerning its river system, besides his incessant botanical, entomological, and meteorological observations, he came upon the territory of the Niam-niam. On the 29th of January, 1870, he set out with four Nubian servants, and thirty Bongo bearers, under the protection of Mohammed Aboo Sammat, a magnanimous Nubian merchant, who, sword in hand, had vanquished various districts large enough to have formed small states in Europe. Of this man the author says:

"Not only throughout the period of eight months did he entertain me and my party in his settlements, seconding all my wishes, but when I desired to explore outlying parts, he lent me the protection of his armed force. Solely because I was supported by him did I succeed in pushing my way to Upper Shary, more than 800 miles from Khartoom, thus opening fresh districts to geographical knowledge and establishing the existence of some enigmatical people. Every thing that Mohammed did was suggested by his own free-will. The purest benevolence prompted him—the high virtue of hospitality in its noblest sense."

They were soon joined by a caravan consisting of 500 bearers and 120 soldiers, and these with women and slaves made a procession in single file of some 800 people. The incidents of their progress are of the deepest interest, but we have no space for their enumeration. From his account of the Niam-niam people we quote the following:

"The social position of the Niam-niam women differs materially from what is found among other heathen negroes in Africa. Whenever I met any women coming along a narrow pathway in the woods, or on the steppes, I noticed that they always made a wide circuit to avoid me, and returned into the path farther on; and many a time I saw them waiting at a distance with averted face, until I had passed by. This reserve may have originated from two opposite reasons: it may, on the one hand, have sprung from the more servile position of the Niam-niam women themselves; or, on the other, it may have been necessitated by the jealous temperament of their husbands. It is one of the fine traits of the Niam-niam men that they display an affection for their wives which is unparalleled among natives of so low a grade, and of whom it might be expected that they would have been brutalized by their hunting and warlike pursuits. A husband will spare no sacrifice to redeem an imprisoned wife, and the Nubians, being acquainted with this, turn it to profitable account in the ivory-trade. They are quite aware that whoever possesses a female hostage can obtain almost any compensation from a Niam-niam."

Between the parallels of 3° and 4° north latitude, and 28° and 29° east longitude from Greenwich, in the very heart of Africa, is a territory of some 4,000 square miles, inhabited by the Monbuttoo. The country of the Niam-niam constitutes its northern and northwestern boundaries:

"This land," Schweinfurth says, "greets us as an Eden upon earth. Unnumbered groves of plantains bedeck the gently-heaving soil; oil-palms, incomparable in beauty, and other monarchs of the stately woods, rise up and spread their glory over the favored scene; along the streams there is a bright expanse of charming verdure, while a grateful shadow ever overhangs the domes of the idyllic huts. In the deeper valleys, trees grow to such a prodigious height, and exhibit such an enormous girth, that they could not be surpassed by any that could be found throughout the entire Nile-region of the north. Beneath the imposing shelter of these giants, other forms grow up, and, rising one above another, stand in mingled confusion."

From his account of the Monbuttoo, of of whom he speaks "as exhibiting a development of indigenous culture entirely different to what can be witnessed all around," we quote the following:

"The two sexes conduct themselves

toward each other with an excessive freedom. The women, in this respect, are very different to the modest and retiring women of the Niam-niam, and are, beyond measure, obtrusive and familiar. Their inquisitiveness was a daily nuisance: they watched me into the depth of the woods, they pestered me by flocking round my tent, and it was a difficult matter to get a bath without being stared at. Toward their husbands they exhibit the highest degree of independence. The position in the household occupied by the men was illustrated by the reply which would be made, if they were solicited to sell any thing as a curiosity: 'Oh, ask my wife; it is hers.' Their general demeanor surprised me very much when I considered the comparative advance of their race in the arts of civilization. Their immodesty far surpassed any thing that I had observed in the very lowest of the negro tribes, and contrasted most unfavorably with the sobriety of the Bongo women, who are submissive to their husbands, and yet not servile. The very scantiness of the clothing of the Monbuttoo women has no excuse. Carved benches are the ordinary seats of the men, but the women generally use a one-legged stool! While the Dinka women, leaving perfect nudity as the prerogative of their husbands, are modestly clothed with skins; while the Mittoo and Bongo women wear their girdle of foliage, and the Niam-niam women their apron of hides, the women of the Monbuttoo—where the men are more scrupulously and fully clothed than any of the nations I came across throughout my journeys—go almost entirely naked."

But, as every page and paragraph of this work is of absorbing interest, we are weary of the mental conflict as to which shall have place in our limited space. We will conclude with the following:

"I always made a rule of eating alone. A solitary European, as he proceeds farther and farther from home, may see his old associations shrink to a minimum; but, so much the more, with pertinacious conservatism, will he cling to the surviving remnants of his own superiority. Nothing can ever divest him of the thought as to how he may maintain the prerogative, which he takes for granted, that he is a being of some higher order. Many a misanthrope, in his disgust at the shady side of our modern culture, may imagine that, to a traveler, in his intercourse with the children of Nature, the thousand necessities of daily life must seem but trifles vain and empty, to be dispensed with without a sigh. Such a one may fancy that the bonds which fasten him to the world of civilization are weak, and all waiting to be rent asunder as soon as Nature is left to assert her unfettered rights; but, from experience, I can assure him that the truth is very different. With the fear of degenerating ever before his eyes, the wanderer from the realms of civilization will surely fix his gaze almost with devotion on the few objects of our Western culture that remain to him, which (however trivial they are in themselves) become to him symbols little less than sacred. Tables and chairs, knives and forks, bedding, and even pocket-handkerchiefs, will assume an importance that could never have been anticipated, and it is hardly too much to aver that they will rise to a share in his affections."

FUNGI: THEIR NATURE AND USES. By M. C. COOKE and M. J. BERKELEY. New York: D. Appleton & Co. "International Scientific Series," No. XV. Pp. 300. Price, $1.50.

A VERY interesting tract of the vegetable kingdom, which has hitherto received but little popular attention, is here reported upon by two of the most eminent English authorities upon the subject. In all that relates to those numerous and curious forms of vegetable growth called *fungi*, in their familiar forms, as seen by everybody in field and forest, and in their still more wonderful microscopic varieties, Rev. M. J. Berkeley, the venerable Rector of Sibbertoft, is perhaps the first authority in the world. Though a hard-working clergyman, he has found time to master and to extend one of the most interesting provinces of botany hitherto as obscure as it is extensive. He engaged to produce a book for the "International Series" upon this subject, but, finding, from the multiplicity of his engagements and his uncertain health, that he could not accomplish it satisfactorily, he associated with himself the next ablest man of England in this field, Dr. M. C. Cooke, who has done the principal work, which now appears under the critical editorship of Dr. Berkeley himself. Readers who desire to become acquainted with the subject-matter of this volume, and to form some general idea of its scope and importance, are referred to the opening article of the present number of the MONTHLY, and, if its perusal

interests them, they will find that the book gives the clearest and fullest account of the subject for common readers that has yet been published.

The following passages are from an able review of it in the London *Athenæum*:

"The present volume may be taken as a general introduction to the previous one, and is of much wider interest than it. Physiologists and botanists have come to recognize and appreciate, much more fully than heretofore, that the solution of many vexed problems in the life-history both of plants and of animals is to be sought in the investigation of the mode of life of those so-called lower organisms, fungi and algæ. Speaking in general terms, we may say that the phenomena of reproduction are at least as well, if not better, understood among these plants, once considered sexless, as among organisms of higher rank, and it seems highly probable that when observers avail themselves of the joint use of chemistry and of the microscope that the essential phenomena of nutrition will also be made clear. English students not familiar with the modern literature of Germany and France are at a great disadvantage in this matter. With the exception of Mr. Berkeley—*salve magne nomen!*—few have devoted themselves to the study of these plants, and still fewer to the study of their physiological history. It has thus chanced that what little most English botanists know of these matters, they have gained in a large degree from condensations and abstracts in scientific journals from the writings of German and French observers. Happily, there have been indications of late that English students are beginning to devote themselves to this difficult but most promising field of inquiry. The discussions on so-called spontaneous generation; the inquiry whether or no fevers and other diseases owe their origin to the introduction and multiplication of germs within the body; the disastrous consequences following the attacks of fungi on vines and on potatoes, all excited interest in the study of these organisms, and induced observers to turn their attention to them.

"From this point of view, Dr. Cooke's book is well timed. It comes at a period when the importance of the study, both from the stand-point of pure science and from that of practical utility, is becoming clearly recognized. Such an epitome of what is known as to the growth of fungi is, therefore, peculiarly welcome, the more so as no modern work of the kind exists, Mr. Berkeley's 'Introduction to Cryptogamic Botany' having been published several years ago, while its style is obscure and its arrangement not suitable to the requirements of beginners. Dr. Cooke's book contains an admirable *résumé* of what is known on the structure, growth, and reproduction of fungi, together with ample bibliographical references to original sources of information.

"One of the most interesting chapters in the volume to the general reader, who does not care to follow the author in the technical, and still somewhat obscure details of the structure and classification of these plants, is that devoted to the influences and effects of fungi. Apart from what are popularly known as poisonous fungi, it is assumed by many that certain diseases, such as cholera, various fevers, measles, diphtheria, etc., are actually caused by the introduction into the system of fungus-spores. Now, there is ample evidence to show that fungus-spores are introduced, and that in some diseases, e. g., diphtheria, fungus-moulds, the result of the development of such spores, have been found, but there is no certain evidence either that the spores or the developed plant has any thing to do with the disease. The opinion of those best qualified to judge is that the fungi are there in consequence of the disease, not the disease in consequence of the fungi. We are glad to see, with reference to this matter, that the author summarizes the important conclusions of Drs. Cunningham and Lewis—the more so as those conclusions, which are based on important observations, are contained in official publications not readily accessible to the general public. Dr. Cunningham establishes without question that the air is always charged more or less with these minute spores, but that no connection can be traced between the numbers of bacteria, spores, etc., present in the air, and the occurrence of diarrhœa, dysentery, cholera, ague, or dengue, nor between the presence or abundance of any special form or forms of cells and the prevalence of any of these diseases. On the other hand, it is a matter of dispute at the present moment whether the minute organisms called bacteria may not be developed in the body itself, and, in some cases, produce fungoid structures in the tissues, and, as a consequence, disease. Throughout the volume we find evidence of the care that has been taken to summarize the most recent information, even to the remedies proposed for the hollyhock-disease in the gardening journals of the present year."

THE AMERICAN GARDEN: a Monthly Illustrated Journal devoted to Garden Art. 24 pages. $2 a Year. Beach, Son & Co., No. 7 Barclay Street, New York.

UNDER the able editorial management of Mr. James Hogg, this journal is doing excellent service in the interest of gardening and fruit-culture. It contains each month a large amount of interesting and valuable matter, characterized, in the main, by a directness of statement and common-sense that quickly win the confidence of the reader, and assure him that he is in the hands of a safe and competent instructor. From the thirty-two titles in the last number, the following may be taken as a fair sample of the variety and practical character of the subjects treated: "Insects injurious to Room-Plants," "Fresh-Water Aquaria," "The Artistic Influence of Flowers," "Tropical Scenery," "About Ferns," "The Truffle," "*Stillingia Sebifera*, or Tallow-Tree," "The Carolina Poplar," "Watering Plants," and "Thinning out Fruit."

BIRDS OF THE NORTHWEST. By ELLIOT COUES, M. D., U. S. A. 791 pages. Washington: Government Printing-Office, 1874.

THE basis of the present volume is mainly an unpublished report prepared by the author, in 1862, upon the ornithological collections made in the Missouri region by the naturalists of the expedition under Captain Reynolds, and afterward extended so as to embrace the ornithological results of previous explorations, in 1856–'57, by Lieutenant Warren, in the region of the Upper Missouri, Yellowstone, and Platte Rivers. In 1872 Dr. Hayden, U. S. Geologist, expressed to the author his desire to publish a treatise on the ornithology of the Western Territories, which he had explored. Dr. Coues undertook the task of elaborating the material collected since the writing of his original report, and the whole result is published in the book now before us, which is believed to be fairly abreast of the present state of the science. To bring the work within the compass of a single volume, and to give it a distinctive character apart from the general work on "North American Ornithology" in preparation by Profs. Baird, Brewer, and Ridgway, its scope is restricted to the Missouri region. The birds of this region, like most others of North America, having been repeatedly and sufficiently described, text of this technical kind has been omitted as a rule, to make room for fresher matter of more general interest, but particular plumages, not yet well known, are described. The distribution of the species, their residence or migration, and their abundance or scarcity, are worked out, not only within the region indicated, but throughout the general area they inhabit. All the species at present known to inhabit this region are given, and represent a large majority of the birds of North America. The author is brief in the cases of the best known Eastern birds, in order to devote more space to the history of species upon which less has already been written. Three families, *Laridæ*, *Colymbidæ*, and *Podicipidæ*, are made the subjects of special monographs.

THE ELEMENTS OF EMBRYOLOGY. By MICHAEL FOSTER, M. D., and FRANCIS M. BALFOUR, M. A. London: Macmillan, 1875. 272 pages. Price, $2.25.

THIS is the first installment of a systematic introduction to the study of embryology. For the sake of making the first steps in this interesting branch of science as easy as possible, the authors consider in the present volume only the embryogeny of the common fowl. The development of the chick once mastered, the study of other forms becomes an easy matter. The work consists of nine chapters, with an Appendix. In Chapter I. we have a description of the egg, and an account of the changes which take place up to the beginning of incubation. Chapter II. is a summary of the history of incubation. The other chapters, down to the ninth, indicate the changes which occur from the first day of incubation down to the end of that process. Chapter IX. is on the development of the skull. In the Appendix are given practical instructions for studying the development of the chick.

IMPROVEMENT OF HEALTH. By JAMES KNIGHT, M. D. 406 pages. Price, $1.50. New York: G. P. Putnam's Sons, 1875.

THIS is the second edition of this book on the improvement of health by natural means, including a history of food and a consideration of its substantial qualities.

The work opens with a statement of the various unfavorable influences that tend to the enervation of the physical powers of parents; and this is followed by an outline of man's organization, development, and proper sustenance, and by an elucidation of the relations which exist between the vegetable and animal kingdoms, whence his subsistence is obtained. The book contains few cuts, and these are poorly made.

CATECHISM OF THE LOCOMOTIVE. By M. N. FORNEY, M. E. 600 pages, 12mo. Price, $2.80. New York: The Railroad Gazette. 1875.

THE object of this book is to furnish a clear and easily-understood description of the principles, construction, and operation, of the locomotive-engine of the present day, a subject not concisely or adequately treated in any one similar book. It is intended not only as a hand-book for all classes of mechanics and railroad-men, but as a readable book of practical information for amateur engineers, students, and general readers. The headings of a few chapters taken at random are: "The Steam-Engine;" "Forces of Air and Steam;" "General Description of a Locomotive-Engine;" "Different Kinds of Locomotives;" "Accidents to Locomotives;" "Responsibility and Qualification of Locomotive Runners." The subjects presented are treated simply and plainly, in the form of question and answer, of which there are 563. The book is illustrated by 230 woodcuts and many plates.

A NEW TREATISE ON ELEMENTS OF MECHANICS. By JOHN W. NYSTROM, C. E. 352 pages, 8vo. Price, $4.00. Philadelphia: Porter & Coates, 822 Chestnut Street. 1875.

THIS new treatise on mechanics has for its object the establishment of strict precision in the meaning of dynamical terms, and the classification of physical quantities into elements and functions. It is written for students of mechanics, by a practical engineer; and the terms adopted in it are those used in the machine-shop, rejecting the ideal vocabulary heretofore used in text-books and colleges; thus the author rejects such terms as "efficiency of force," "working force," "quantity of motion," "mechanical power," "mechanical effect," "energy," etc., as having no definite meaning, or being redundant expressions meaning "force," "power," or "work." The first 56 pages treat of "Statics," and the next 221 pages are given to "Dynamics." A short chapter on the "Dynamics of Sound," a chapter on the "Mechanics of Astronomy," and an Appendix elucidating a duodenal system of arithmetic, measures, weights, and coins, complete the work, the whole of which is illustrated by 242 woodcuts.

FAMILIAR LECTURES ABOUT THE TEETH. By HENRY S. CHASE, M. D. 68 pages, cloth. St. Louis: Gray, Baker & Co.

THE contents of this neat little publication are designed particularly to enable *mothers* to understand and take care of the *growth* of children's teeth. The author first gives several illustrations with descriptions, showing the position of the teeth in the jaws, together with the usual time of appearance of the milk-set and permanent set of teeth. He then treats of the structure of the teeth, the changes they undergo, and the nutrition which they demand, the same as other parts of the body. The food must furnish bone-material as well as flesh-material. Phosphate of lime gives hardness to the teeth and bones, but it must be organized by a plant before it becomes fit food for an animal: "Artificial salts will not nourish the teeth by being taken as food; yet some persons have recommended that they be put into bread for that purpose." Other subjects are "Early Growth of the Teeth," "Infants' Teeth," "Dental Decay," "Children's Teeth," "The Six-Year Molars," "Plugging Teeth," "Effects of Medicine on the Teeth," "Diseases of the Teeth," "Extraction of Teeth," and "Artificial Teeth." The book is a good one, and will fully repay an attentive perusal.

A NEW MANUAL OF PHYSIOLOGY. By Prof. KÜSS. Boston: James Campbell, 1875. 531 pp., 12mo. Price, $2.50.

THE contents of this volume are a course of lectures on physiology, delivered by Prof. Küss, at the Medical School of the University of Strasbourg; edited by Mathias Duval, M. D., of the Medical Faculty of Paris; and translated by Robert Amory, M. D., formerly Professor of Physiology at

the Medical School of Maine. The object of the work, as stated in the preface, is to supply the want of an English text-book in which the functions of living tissue are closely compared and combined with its texture; or, in other words, a book wherein the relations of physiology to histology are carefully presented; for, while there are many good works on physiology, to which the student can refer for a knowledge of the subject, a concise treatise, within the limits of the means of medical students, has been a want hitherto supplied only by treatises in French or German. The book is embellished with 150 woodcut illustrations.

REPORT OF THE COMMISSIONERS OF LUNACY TO THE COMMONWEALTH OF MASSACHUSETTS. Boston, January, 1875.

THIS pamphlet of 76 pages contains the separate Reports of the Commissioners, Nathan Allen and Wendell Phillips, to which is added, in an appendix, a letter to the Commissioners by S. E. Sewall. The Report gives the number of insane in the State as, approximately, 3,624, but the Commissioners are persuaded that, if more thorough measures were taken for ascertaining the number, they would exceed *four thousand*.

WE observe with pleasure the addition of four pages to the *Engineering and Mining Journal*, edited by Richard P. Rothwell, C. E., M. E., and Rossiter W. Raymond, Ph. D. Heretofore its weekly issue consisted of sixteen pages, now it is twenty. But, besides enlarging, the publishers announce their intention of otherwise adding to the value of the journal. Thus they will make more liberal use of engravings to illustrate subjects of professional interest, and questions of practical importance in mining, metallurgy, and gas-engineering, will receive special attention. Another new departure, something in the nature of *Notes and Queries*, is announced, and cannot fail to enhance the value of the paper. It is the publishers' desire to have their pages used as a "medium for asking and giving information on subjects connected with mining and metallurgy, or general science." Subscription, $4.00. Publication-office, 27 Park Place, New York.

INTERNATIONAL SCIENTIFIC SERIES.—If the last volume of this series, on "Fungi," be thought somewhat remote from the urgent solicitudes of the American mind, no such objection can be urged against the contribution of Prof. Jevons to this series, now in press, entitled "Money and the Science of Exchange." Prof. Jevons is not only a logician of originality and eminence, and author of a recent profound work on the "Principles of Science," but he is a professional student of political economy, and the author of important works upon this subject also. He brings a disciplined mind and a comprehensive knowledge of the subject to the discussion of that important branch of economical science which deals with currency, and may be expected to give in his new volume a clear and compact statement of the subject, as far as its scientific principles have been worked out. Such a volume cannot fail to be useful in this country, where the interest in money is so intense as to be surpassed only by the general ignorance of its nature, offices, and laws.

"THE UNSEEN UNIVERSE."—Under this title an anonymous work will be shortly issued from the press of Macmillan, treating of the religious bearings of the most advanced science, in such a way as to arouse the interest of both scientific and religious thinkers. Since its announcement the work has been anxiously looked for, and there is much speculation as to its authorship.

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PUBLICATIONS RECEIVED.

The Religion of Humanity. By O. B. Frothingham. Pp. 338. New York: Putnam's Sons. Price, $1.50.

Home Sketches in France. By Mrs. Henry M. Field. Pp. 256. New York: Putnam's Sons. Price, $1.50.

Fifth Catalogue of Seventy-one Double Stars. By S. W. Burnham, Esq. Duplicity of the Principal Star of New Scorpii (same author). Reprint from Royal Astronomical Society notices.

Iron and Steel. By Adolf Schmidt, Ph. D. Pp. 12. St. Louis *Times* print.

History of Greece. By C. A. Fyffe (His-

tory Primers). Pp. 127. New York: Macmillan. Price, 40 cents.

Pneumo-thorax. By Austin Flint, Sen., M. D. (series of American Clinical Lectures). Pp. 18. New York: Putnam's Sons. Price, 40 cents.

Spectroscopic Examination of Gases from Meteoric Iron. By Arthur W. Wright. Pp. 8.

The Past and Future of Geology. By Joseph Prestwich, M. A., F. R. S. London: Macmillan. Pp. 50. Price, two shillings.

Possibility and Probability of Supernatural Revelation. By Rev. Horace Bumstead. Pp. 15. Minneapolis: Johnson & Smith.

Doubt. By J. N. Stiles. Pp. 19. Chicago: Beach, Barnard & Co.

Philadelphia School of Anatomy. By William W. Keen, M. D. Pp. 32. Philadelphia: Lippincott.

Skew Arches. By E. W. Hyde, C. E. Pp. 104. New York: Van Nostrand. Price, 50 cents.

The Iron-clad Ships of the World. By M. P. Dislere. Pp. 29. Washington: Government Printing-Office.

The Centennial of Chemistry. Pp. 208. Philadelphia: Collins, Printer. Price, $1.00.

Cretaceous Lamellibranchs, collected at Pernambuco. By Richard Rathbun. Pp. 15.

Journey in Honduras. By R. C. Huston, C. E. Pp. 39. Cincinnati: R. Clarke & Co. Price, 50 cents.

Catalogue of American Grape-vines. Bush & Son, Bushberg, Jefferson County, Mo.

Transits of Venus (Proctor). New York: Worthington.

Manual of Diet in Health and Disease (Chambers). Philadelphia: Henry C. Lea.

Navigation, in Theory and Practice (Evers). Putnam's Sons.

Theology of the Coming Man. By G. Eppley, M. D. Pp. 11. Lewisberry, York County, Pa. The Author.

Vertebrata of the Eocene of New Mexico (Cope).

Theory of Solubility (Walz). Philadelphia: Collins, printer.

Causes of Irregularity in Development of the Teeth (Kingsley).

Munroe's Philosophy of Cure.

## MISCELLANY.

**Disastrous Balloon Ascent.**—On the 18th of April the balloon Zenith made an ascension from Paris, carrying three aëronauts, Messrs. Gaston Tissandier, Sivel, and Crocé-Spinelli. All three were aëronauts of long experience, and qualified in every way for making accurate scientific observations on the meteorological phenomena of the upper strata of the atmosphere. They carried with them a full set of such philosophical instruments as would be of service in ascertaining elevations, constitution of the atmosphere, temperatures, and the like. They carried also a supply of pure oxygen, for use when the air should be found too rare to support respiration. Having risen to the height of 7,000 metres (22,960 feet), Tissandier observed that his companions looked pale; he himself felt weak, but refreshed himself by inhaling a little of the oxygen. Sivel soon after threw out ballast, and the balloon commenced to ascend rapidly. All at once Tissandier was so feeble that he could not even turn his head; he tried to seize the oxygen tube, but was unable; his mind still lucid. Looking at the barometer he saw that it indicated an elevation of 8,000 metres (26,240 feet), but he had not the strength to call the attention of the others to the fact. He soon after fell into a sort of swoon, but twenty minutes later revived for a moment, finding the balloon descending rapidly. Sivel and Crocé were now lying at the bottom of the car insensible. Again he sank fainting, and a few minutes later found himself shaken by the arms, and, looking up, recognized Crocé, who told him to throw out ballast, for the balloon was descending at a very rapid rate.

Crocé now unfastened the aspirator and threw it out, as also some ballast, extra wraps, and the like. This caused the balloon again to ascend, and Tissandier relapsed once more into insensibility. On recovering consciousness, he found the car rushing

downward with frightful velocity. He tried to arouse Sivel and Crocé, but they were immovable; Sivel's face was black, his eyes dull, mouth wide open and full of blood. Crocé's eyes were closed, and his mouth blood-stained also. Having come down to the earth, Tissandier dropped the grapnel, but it failed to hold firmly, and the car was dragged across the fields by a violent wind. He succeeded, however, in grasping the cord of the valve, and the balloon was soon emptied. Crocé-Spinelli and Sivel were dead. Tissandier was in a high fever, but he was kindly cared for by the inhabitants of the village of Ceron, in the vicinity of which he landed, after having been in the air over three hours.

The disaster attending this memorable ascent has delayed the publication of the scientific results of the voyage. These, however, are understood to be of high importance, and we will present them to our readers at an early day. The greatest altitude observed by M. Tissandier was not very remarkable, when compared with Glaisher and Coxwell's highest in 1862. These aëronauts reached the enormous altitude of 37,000 feet, which is more than 10,000 feet in excess of Tissandier's 8,000 metres. But, while Tissandier lay insensible, the Zenith may have attained still greater elevations; this question will be decided by the records of the self-registering barometers, which were sent to the French Academy under seal.

**Cave Explorations.**—A number of caves containing the remains of animals were recently discovered in Worcestershire, England, on the banks of the river Wye. At a meeting of the county Scientific Society the president described a visit made by him to these caves, in company with Dr. Carpenter. Three of the caves only were visited. In one were found three human skulls, with coins and ornaments belonging to the Roman period. The soil in which these objects were buried having been removed, the explorers found a layer of solid stone, so thick and hard that it had to be blasted with gunpowder. Under this layer were found bones belonging to a single animal—*Ursus spelæus*. Another layer of stone was then likewise removed by blasting, and the explorers found fossil bones of sundry extinct species, viz., the remains of a mammoth, in a state of wonderful preservation; all the bones of a rhinoceros; the *débris* of cave-lions, cave-bears, and also of several hyenas. The Worcestershire Scientific Society intends to acquire possession of one of the caves.

**Origin and Distribution of Ammonia in the Air.**—In a communication to the French Academy of Sciences, Schlösing states as follows the results of his researches on the origin of the ammonia diffused on the surface of the soil, its circulation, its variations in the atmosphere, and its distribution between the sea, the continents, and the air. It is a well-known fact that, in the course of the transformations of organic matter, a certain amount of nitrogen is set free; also that this gaseous nitrogen is not assimilable by organisms. Hence the necessity of some agency which shall take this free nitrogen and cause it to reënter into combination. The author, after criticising the various opinions put forth on this subject, assents to the theory of Boussingault, who holds that, under the influence of atmospheric electricity, nitric acid is produced in the air. Further, he says that the surface of the continents is essentially an oxidizing medium; that nitrification is there abundantly developed; and that a portion of the nitrates thus formed enters again into the cycle of life, while the rest is carried into the sea. Experience also shows that if the decomposition of organisms produces nitre on the continents, it produces ammonia in a medium so little oxidized as is the sea. Hence the author recognizes on the surface of the globe a regular circulation of nitric acid and of ammonia, taking place in this way, viz., nitrous production in the air, nitrous gains from the air to the continents, transfer of nitrates to the sea, formation of ammonia in the saline medium; finally, disengagement and passage of the alkali into the air, to be given back again to the continents.

**Mortuary Statistics of Virginian Cities.**—The following mortuary statistics, taken from the official reports of three Virginian cities, would seem to show that the African race is declining in the Southern States:

The total white population of Richmond is given as 33,452, and the deaths for January 25 males and 16 females. The colored population of the same city is given at 27,213, and the deaths as 40 males and 36 females. Norfolk had, for the same month, in a white population of 12,000, 3 male deaths and 5 female, while its colored population of 8,000 gave 6 male and 7 female deaths. The white population of Lynchburg is 6,500, and the colored population the same. Among the whites there were 4 males died and 1 female, while among the colored people 8 males died and 10 females. In Richmond, the number of still-born infants in the white population was 5, in the colored 11; in Lynchburg the number was 3 and 7 respectively. In Norfolk the number was even.

**Temperature of the Body in Disease.**—The normal surface temperature of the human body, in temperate climates, is about 98.°5, any persistent variation from this, whether by depression or by elevation, indicating disease. In the tropics, the normal temperature is one degree higher. Hitherto it has been supposed that, when in fevers the temperature rises over 108°, recovery is impossible, unless a reduction is effected by the cold bath. The *Lancet* gives an instance of recovery where the thermometer indicated a temperature of over 122° in the armpit of a patient suffering from injury to the spine. The history of this extraordinary case is as follows: On September 5, 1874, a young lady met with an accident in the hunting-field, whereby two ribs were fractured; at the same time she complained of pain in the back. A surgeon, Mr. J. W. Teale, was soon in attendance. A few days after the accident the temperature was 101°, but, in the space of a fortnight, it became normal. The fractured ribs united, but pain and tenderness still existed over the sixth dorsal spine. On October 3d the temperature rose to 100°, and then to 101°; and it still continued to rise in spite of the application of ice-bags to the spine, till, on November 6th, it was 106°. After many fluctuations, the temperature, on the 13th of November, reached the astonishing height of 122°, the index of the thermometer becoming buried in the bulb at the top of the instrument, which registered only up to 122°. During that day there was a fall of 8°, but, in the evening, 122° was again reached.

As a general rule, an increase of 1° above the normal temperature is attended with an increase of ten beats of the pulse per minute. In the present case, the pulse appears to have been the same (120) at 122° as at 108°. The normal temperature was not reached till January 10th, and, during the space of seven weeks, it never fell below 108°. We must add here that every precaution was taken against error in the indications of the thermometer. No fewer than seven different instruments, made by Harvey & Reynolds, were used, of which four had received certificates of correctness at Kew. Further, they were inspected by two or three trustworthy witnesses before and after each application, and the results were always immediately recorded in writing. Sometimes, when the thermometrical readings were highest, the hands, feet, and forehead, were icy cold, and the patient felt as if "her blood was on fire."

**"Cotton Gunpowder."**—This is the name given to a preparation of gun-cotton which, by the use of certain chemicals, is rendered perfectly safe for storage or carriage, though possessing enormous explosive power. The following account of some experiments made with cotton gunpowder we take from the *Journal of the Society of Arts:* "Cartridges were held in the hand, lit with fuses, and burned with a steady blaze, while, when ignited by detonators, they exploded with a loud report. Ten pounds of the substance was placed on an anvil, and an iron pile-driver weighing one-half ton was allowed to fall 15 feet upon it, without causing an explosion. Two barrels, each containing 40 pounds, were placed in a pile of fagots. Upon these being fired, the powder burned with a steady but intense flame, and without any tendency to explosion. A solid block of steel, about one-half ton in weight, was bored to the depth of 6 inches, and a 6-ounce cartridge was inserted in the hole. It was split into two pieces. But the greatest exhibition of force was made in two experiments with

steel ingots. In the first experiment, 4 ingots of 8 inches square and 3 feet long were used. In the centre of these four masses of steel as laid together, two pound cartridges of the powder were placed, and kept in their place with a few handfuls of clay. In the second experiment the four ingots were each 11 inches square, and the charge used 2½ pounds. The 8 ingots were all broken in halves; some of these massive pieces of steel were sent flying high in the air, falling 30, 35, and, in one case, 45 yards away. At the close of the experiment, a torpedo of 50 pounds of this powder, sunk 10 feet in the river Swale, but not resting on the bottom, was fired. An immense body of water was projected high in the air, and any vessel which might at the time have been passing over it would have suffered severely."

**A Thorough State Survey.**—Prof. N. S. Shaler publishes in the *Atlantic Monthly* an article on a survey of Massachusetts, advocating a more minute reconnoissance of the topography, geology, zoölogy, botany, agricultural resources, climate, etc., of that Commonwealth, than has hitherto been attempted with respect to any portion of the territory of the United States. In this great enterprise, the first thing to be done is, to secure the best map. Massachusetts has the good fortune to have her shore-belt map completely made by the Coast Survey. Cape Ann and Cape Cod, and the bordering islands, constituting about a tenth of the total area of the State, have all been done on a scale of $\frac{1}{10000}$, or about six inches to the mile of distance. The entire State, on the same scale, would be represented in a record-map about 90 by 54 feet. "On this plan," says Prof. Shaler, "the surveying and improvement of private grounds could always be accomplished, tax-levies made, and, in short, our civilization could be organized upon it." In this way the topographical portion of the survey would probably cost not over $750,000, a sum which Massachusetts could easily afford.

In the geological survey, every stratigraphical question, every question in chemical geology, should be followed to its utmost point. Some of the problems which would arise are economical, have money in them; the others are economical too, in that higher sense which finds all truth profitable. The problems of direct economical interest are: distribution of water, its storage and quality; building-stones; deposits of coal; distribution of metals; reclamation of marshes; retimbering of the exposed parts of the coast, etc. As for purely scientific problems, probably no other known fossils have so much value for the science of to-day as those wonderful footprints of the Connecticut Valley.

A large part of the necessary work for the complete description of Massachusetts animals and plants is already done, and only needs to be brought together and classified. The State already has nearly $1,000,000 invested in the Museum of Comparative Zoölogy, and, in the work of cataloguing the animals, this noble institution can make a substantial return through the students it has trained and the collections it has made. With good maps and good catalogues of the natural productions of a country, the teaching of natural science becomes possible to a degree that cannot be hoped for under other circumstances.

**The Microscope as a Detective.**—The microscope, as an agent in the detection of crime, has been alternately commended and condemned. It was recently employed in a Connecticut court of justice to discover, in the clothing of a man charged with murder, minute filaments from the shawl of his alleged victim. Dr. J. G. Richardson lately read before the Philadelphia Academy of Natural Sciences a paper on the "Value of High Powers in the Diagnosis of Blood-Stains," in which he shows that the red blood-globules of various domestic animals, as the ox, cat, pig, horse, sheep, goat, are all so much smaller than the human red disk, that we can positively distinguish stains produced by human blood from those caused by the blood of any of these animals. To furnish positive demonstration of the facts of the case, Dr. Richardson obtained six specimens of blood-clot, from the veins of a man, an ox, and a sheep, selected without his knowledge, and so marked as to furnish no clew as to which animal they were derived from. By the microscopical characters alone he was able to determine with perfect correct-

ness the origin of every one of the samples. The corpuscles of the human blood averaged $\frac{1}{3450}$ inch diameter, those of the ox-blood $\frac{1}{1674}$, and the sheep's blood $\frac{1}{3937}$.

**The Cincinnati Zoological Garden.**—We are indebted to Mr. G. H. Knight, of Cincinnati, for an account of the Zoölogical and Botanical Garden about to be established in the northern suburbs of that city. The projected garden is to be, as far as possible, a complete representation of the fauna and flora of this continent. Efforts will be made to render the ground a complete *arboretum*, in which each tree and shrub will be plainly labeled according to the scientific classification, with the common name appended. Fresh and salt-water aquariums, on a large scale, will add to the popular attractions as well as to the scientific value of the establishment. Nor will the collection be restricted to a representation of the animal and vegetable worlds; there is also to be a novel geological feature added, viz., an artificial section of the earth's crust, made up of the actual component rocks in their natural positions, accompanied, possibly, by some of their paleontological characteristics; that is to say, their extinct fauna and flora restored. The tract of land secured for this garden is, for the most part, an elevated plateau of about sixty-seven acres, very central and accessible in location. The Cincinnati Zoölogical Society, to whom all the credit of this great enterprise is due, have already in hand over $100,000 for the beautification of the grounds and the construction of the necessary buildings, laying out of paths, etc. A naturalist, who brings a large practical experience in the care of wild animals, and a landscape-gardener, who has been engaged in similar works elsewhere, have been engaged, and are already busily at work examining the ground and making necessary preparations.

**The Dietetic Value of Gelatine.**—The theory that gelatine passes through the system undigested, and thus contributes nothing toward the nourishment of its tissues, has recently been subjected to a re-examination by Etzinger, with results that appear to contradict the current view. By submitting fine gelatine, and also the various gelatine-yielding tissues, such as bones, cartilages, tendons, connective tissue, etc., to the action of artificial gastric juice, he shows, in accordance with Boerhaave and others, that gelatine is digestible, breaking up and becoming dissolved more or less rapidly, according to the form in which it is presented to the solvent. Being satisfied on this point, the next question was, "Is the gelatine, after solution or digestion, of any service in nutrition?" To determine this, a careful dieting of animals was instituted, with coincident analysis of their urine and fæces. The results showed that, in the cases of bone, cartilage, and tendons alike, these substances not only undergo digestion, but are absorbed into the blood, and play an important part in nutrition. Instead, therefore, of being entirely cast aside as useless articles, they may be consumed in moderate quantities with decided advantage.

**The Origin and Structure of Fulgurites.**—Mr. Frank Buckland publishes, in *Land and Water*, an account written by his father, the late Prof. Buckland, of certain vitreous tubes discovered in sand-hills, near Drigg, in Cumberland. Three of these tubes were found on a single hillock about thirty feet above the level of the sea, the diameter of each being about an inch and a half. An excavation having been made about one of them, it was found to descend perpendicularly through the sand about thirty feet. At about twenty-nine feet, the sand was succeeded by a bed of pebbles. Here the tube came in contact with a piece of hornstone porphyry, from which it glanced off at an angle and then resumed its vertical position. Below this point the tube, becoming extremely delicate, was frequently broken, and at the distance of a foot the sand fell in, preventing further investigation. The tube appears to have tapered in its descent, its diameter at the bottom of the excavation being only half an inch. Small lateral branches proceeded from different parts of the stem, not over two or three inches in length, nor one-quarter inch in diameter at the points of insertion. They were conical, the points being turned downward. The outside of the tube is coated with an agglutinated sand, which, viewed with a lens, is seen to consist of black and opaque

white grains mixed together and rounded as if by instant fusion. The wall of the tube is about one-twentieth of an inch thick, and very solid and rigid. In the opinion of Prof. Buckland, lightning is the only agent that could at once supply the heat and force necessary to make these tubes.

A similar tube, coming from North Carolina, has been described by Prof. Leeds, of the Stevens Institute. In this case the lightning had penetrated a bed of pure white sand, melting the silex, and forming a hollow shaft two or three inches in diameter and four feet long, filled within and surrounded without by the pure white sand of the locality. The shaft, however, was discolored by finely-divided metallic iron (which does not exist in Nature at the earth's surface), and the explanation seems to be that at the immensely high temperature at which silica melts, iron dissociates from oxygen, and that here, dissociation having occurred, the metallic iron, transported by the electric flux from some subterranean depth, became incased in molten sand, and was preserved unoxidized in the vitreous tube.

**The Weakness of a Great Man.**—The vanity of the great botanist Linnæus was extraordinary, as witness the following document written by his own hand, and entitled "The Good Fortune, Services, and Fame of Linnæus:" "God gave him to wife the woman he most loved, and who cared for the household while he studied. God granted him the largest herbarium in the world, and this is his delight. God honored him with a title (chief physician), orders (knighthood), coat-of-arms (nobility), and a name among the learned. God saved him from a conflagration. No man before him ever pursued his special study with greater zeal, or had more listeners. No man before him was ever more famous throughout the whole world." The same trait of character is seen in "Flora's Body Guard," as Linnæus, curiously enough, called the most eminent botanists of his day: "General, Karl von Linnæus; major-general, Bernard Jussieu; colonels, Albrecht von Hall and J. F. Gronovius; lieutenant-colonels, Burmann, Gleditsch, Ludwig, etc.; major, J. G. Gmelin;" and so on. A lady having once visited Linnæus's cabinet, the great man made a profound impression on her by giving her some interesting information about each specimen. At last she exclaimed, "I can now understand why Linnæus is so famous in the whole province of Upsala." But Linnæus, who had expected to hear "all over the world," instead of "in the province of Upsala," was hurt by the meagreness of the lady's adulation, and dismissed her curtly enough. In order to sound the depths of the great botanist's vanity, an acquaintance once saluted him as the Sun of Botanists, the Jupiter of Scholars, Nature's Secretary, an Ocean of Knowledge, a Traveling Mountain of Erudition, and the like. Far from being displeased at such fulsome flattery, Linnæus interrupted the panegyrist at the close of each phrase, embraced him, and again and again called him his best and dearest friend.

**Perception of Color by Bees.**—To test the faculty possessed by bees of distinguishing between colors, Sir John Lubbock brought a bee to some honey, which he placed on blue paper, and about three feet off he placed a similar quantity of honey on orange paper. After the bee had returned twice he transposed the papers, but the bee returned to the honey on the blue paper. After she had made three more visits, always to the blue paper, he transposed them again, and she again followed the color, though the honey was left in the same place. The papers having been again transposed, the bee returned to the former site of the blue; but, when just about to alight, she noticed the change of color, and without a moment's hesitation dashed off to the blue. No one, says he, who saw her at that moment, could have entertained the slightest doubt of her perceiving the difference between the two colors.

**Poisoning with Extract of Hemlock.**—The following is a condensed history of the remarkable case of Frederick W. Walker, who died in Brooklyn, on the 3d of April, from an overdose of extract of hemlock, taken with the hope of controlling the symptoms of an annoying and obstinate complaint. The rare force of will and coolheadedness displayed by the patient in noting and detailing the effects of the drug up

to almost the last moment of his life, recall the celebrated case of Amédée Berthollet, who, while dying of suffocation by charcoal-gas, kept a record of his sensations as long as he was able to hold the pen.

Some time before his death, Mr. Walker had been struck in the temple by a truck-pole, the result of which injury was blepharo-facial paralysis, or spasms of the facial muscles and the eyelids. These symptoms were extremely troublesome in themselves, the spasms often continuing for hours at a time; but scarcely less annoying was the fact that the contortions came on without premonition, and thus the patient often had the misfortune to excite the derision of others by the hideous grimaces which he could not control. The best medical advice had been resorted to without avail. Brown-Séquard performed many severe operations on the patient, such as actual cautery and severing of the facial nerves; the surgeon even cut out considerable portions of nerve-fibre in the attempt to control the spasms. Brown-Séquard having returned to Europe, Mr. Walker came to Prof. C. R. Agnew for treatment. Dr. Agnew tried to relieve the spasm of the right eyelid by dividing the muscle which surrounds the corner of the eye; but the operation failed. On Saturday, April 3d, Mr. Walker visited, by appointment, Dr. Agnew's office, for the purpose of being treated with the extract of *Conium maculatum*, or hemlock. The drug was administered by Dr. Webster, Prof. Agnew's associate; the first dose, forty drops, being taken at 10.25 A. M. At 10.50 the dose was repeated, as also at 11.15, and half an hour later sixty drops more were given. No effect was observable. The patient was then directed to obtain from Dr. Squibb, of Brooklyn, an ounce of his fluid-extract of conium, and to follow minutely that physician's directions as to its administration. Both by Dr. Webster and by Dr. Squibb Mr. Walker was again and again charged to stop taking the conium the moment he "felt any effect of the drug, *such as muscular relaxation, or vertigo.*" The dose recommended by Dr. Squibb was fifty drops, to be repeated in half an hour, in case the symptoms did not present themselves. From the record taken down from the patient's own lips, it is clear that the admonitions of the doctors were disregarded. We give the record, to show the stoical calmness of the man, while the shadow of death was gathering upon him:

"4.10 P. M., took fifty minims Squibb's fluid-extract of conium (hemlock); 4.40 P. M., effect very decided in dizziness, relaxation of muscles and limbs; fifty minims more then taken; difficulty of walking immediately and want of power to control movements; forced to lie down, but no mitigation of spasms, limbs and legs weak, unable to hold up head, speech thickening some, pain and heaviness in top and back part of head; pulse fifty-six.

"5.15 P. M., took fifty drops; some nausea, some tremor at base of clavicle and in muscles across the chest, just above the sternum; no diminution of spasms about eyes nor of photophobia.

"5.25 P. M., drowsiness; inclined to sleep.

"5.40 P. M., eyes difficult to open, speech difficult, fullness in throat, prostration nearly complete, diplopia (double sight) vastly increased.

"6.10 P. M., nausea, twitchings on right side, unable to articulate, eyes closed, fullness almost to suffocation in throat, pulse about sixty. At eight in part—" He never spoke again.

**A New Respirator.**—A respirator, intended for the use of miners, firemen, and others, whose duties so often expose them to danger by the inhalation of deleterious gases, was recently tested at the Barclay & Perkins Brewery, London. The apparatus is the invention of a Frenchman, Denayrouze. It consists of a tube about an inch in diameter internally, made of flexible spiral wire and India-rubber, and so strong and well protected as to bear the weight of a heavy man without collapsing. The tube is attached to a belt which is firmly buckled to the waist of the operator. The mouth-piece is very ingeniously contrived for holding in the mouth with extreme tenacity and the minimum of inconvenience. There is a glazed eye-protector, which also closes the nostrils. Inspirations are taken through the tube, and the respired air is discharged through a valve half-way between the belt and the mouth-piece. By drawing a long

breath through the tube and removing the mouth-piece a simple sentence can be loudly spoken, care being taken not to inhale without first restoring the mouth-piece. The tube is of sufficient length to communicate by one end with the outer air. A newly-emptied vat, of 1,000 barrels capacity, was selected for the scene of the experiment. Lighted candles, dipped one-eighth of an inch into the vat, were instantly extinguished without a flicker, thus showing that the air within was utterly irrespirable. The London agent of the patent, Mr. Applegarth, having put on the belt, and adjusted the mouth-piece and the eye-preservers, descended into the vat by a ladder, and, having reached the bottom, carried on a conversation with those outside, the tube serving as a speaking-trumpet.

**Robert Hardwicke.**—We have to record the death of Mr. Robert Hardwicke, the respected publisher, of London, which occurred on the 8th of March last, resulting from a stroke of paralysis with which he was seized a few weeks previously.

Mr. Hardwicke was well known by the number of useful hand-books on general science and natural history published by him at his house in Piccadilly; most of these works were beautifully illustrated, and sold at very moderate prices. But Mr. Hardwicke will be best remembered by his desire to popularize science. In this field he was an earnest and indefatigable worker, not from a wish to raise an army of pseudo-philosophers, but with the truest intention of elevating the standard of mental culture among all classes, and preparing the masses to follow and appreciate the work of those great minds who devote their lives to science.

In 1862 he started the *Popular Science Review*, a quarterly journal, and in 1865 issued *Science Gossip*, a charming little monthly, well illustrated, and sold for so small a sum as 4*d*. In 1869, under the heading of the *Monthly Microscopical Journal*, he undertook to publish the "Transactions of the Royal Microscopical Society," in conjunction with matter bearing on the same subject.

These ventures were highly creditable to the spirit and enterprise of Mr. Hardwicke, but were not so profitable as they deserved to be; they were, however, a success, and were continued up to the time of his death.

What Charles Knight was to general literature, Robert Hardwicke was to science. It was the aim of both to circulate in the homes of the people pure and readable matter, light and interesting, but worthy the perusal of reasoning beings. With Hardwicke, his work was a labor of love, for he thought that "the high prerogative of every advocate of scientific truth was not to plume himself upon his own successes, but to employ them for the good of others."

**Carnivorous Plants.**—The list of known carnivorous plants has been very considerably enlarged during the past year or two, many interesting additions having been made by sundry observers. To Mrs. Mary Treat is due the credit of having materially increased the fund of scientific knowledge with regard to this description of plants. We have already mentioned her observations on sundew, and now we have to recount her very full researches on the bladder-wort (*Utricularia clandestina*), a plant common in shallow ponds and swamps. This plant owes its vulgar name to the fact that its stem has attached to it numerous little *bladders*, the use of which has been supposed to be to float the plant. But they serve a different purpose. In December, 1874 the author placed some of these bladders under the microscope, and noticed a number of animalcules within. This discovery led to further researches during the following October. It was then found that the bladder consists of irregular cells, with clusters of star-like points (the office of which is still unknown), arranged very regularly over the inner surface. The animal most commonly seen entrapped in the bladder was a snake-like larva; but for a while the author was baffled in her efforts at finding out how the prey is taken. Soon, however, this difficulty was overcome, and the patience of the author was amply rewarded by a view of sundry animals entering into the maw of the utricularia.

One end of each bladder resembles a tunnel-net, open at the larger end and closed at the smaller. The animalcules

would sometimes dally about the entrance for a while, but eventually would venture in and push open the closed end of the net; this then closed, and the animalcule was a prisoner. In this way various minute animals—water-bear, daphnia, cyclops, cypris—were seen to enter the chamber of death. No sooner was the victim within, than it manifested alarm, drew in its feet and antennæ, and closed its shell. After death the shell unclosed again, displaying the feet and antennæ. Not one was ever seen to escape. But, now, how was the observer to know that these animals became the food of the plant? This question occupied the author for several days. If it could be proved that the contents of the bladders were carried directly into the circulation of the plant, the problem was solved. The cells were, in many instances, of a red color, and in all such cases it was observed that the stem at the point where the bladder grew was of the same color. It thus looks "as if a red fluid was carried from the bladders into the main stem, which is not specifically the fact, so far as the observations yet made determine, though the main point, that the contents of the bladders are carried into the circulation, does not seem open to question."

**Darwinism by Descent.** — Mr. Darwin, many people know, has an hereditary claim to the apostolate of the doctrine of evolution; but Dr. Erasmus Darwin's poems have long ceased to be read by the multitude, and it is not so well known how closely his philosophical creed tallies with that of his accomplished grandson. As an example, however, we take the following passage from "The Economy of Vegetation:"

"Organic life beneath the shoreless waves
Was born and nursed in Ocean's pearly caves.
First forms minute, unseen by spheric glass,
Move on the mud or pierce the watery mass;
These, as successive generations bloom,
New powers acquire, and larger limbs assume,
Whence countless groups of vegetation spring,
And breathing realms of fin, and feet, and wing."

In a note combating the "prejudices" against the doctrine of spontaneous vital production, Dr. Darwin holds that "there is more dignity in our idea of the Supreme Author of all things, when we conceive him to be the cause of causes, than the cause simply of the events which we see;" and further on intimates the unlikelihood of the larger and more complicated animals being thus produced, as they "have acquired their present perfection by successive generations during an uncounted series of ages."—*Iron.*

**Antiseptics and Infusorial Life.** — M. Parmille points out that, according to the investigations of Calvert and others, charcoal, lime, and permanganate of potash, contrary to the received opinion, facilitate rather than hinder putrefactive changes, and actually favor the formation of animalcules. Charcoal, when employed for the purification of water, undoubtedly absorbs offensive gases, and removes dissolved flavoring and coloring matters. But upon living animalcules and their germs it has no destructive effect—if any thing, rather promoting their development. Water containing a known amount of "albuminoid ammonia," when experimentally filtered over animal charcoal, has been found, on analysis, worse than before. M. Danaim found that treatment with charcoal increased the poisonous qualities of putrid blood; the explanation offered being that absorption of the gases dissolved in the liquid removed an obstacle to the development of the infusoria. Permanganate of potash is likewise without effect on living organisms, although it rapidly destroys the dead organic matter. The author considers carbolic, or, better still, cresylic acid, as the only agent which extirpates these animalcules.

**Tenacity of Life in the Wheel Animalcule.**—It has been asserted that the wheel animalcule (*Rotifer vulgaris*) may be restored to life by the application of moisture, after having been dried up, and to all appearance dead. This subject has been investigated by Prof. Leidy, and his results show that there is a very definite limit to the tenacity of life in these minute animals. Two glass slides, containing, beneath cover-glasses, some dirt, exhibited each about twelve living rotifers. After exposure to the sun's rays, the temperature being 80°, for half an hour, the moisture on the slide was dried up. The next morning water was ap-

plied, and soon the microscope showed some of the rotifers to have revived, while others remained motionless. The same slides were again submitted to drying, the cover-glass of one having been removed. Several hours after moistening them, the next day, only two rotifers were seen to be alive on each slide. Again some twenty active rotifers were exposed to the hot sun during the afternoon. These could not be revived the following morning. From all this it would appear that rotifers become inactive in comparatively dry positions, and may be revived by supplying moisture; but, when their own substance is actually dried up, it is impossible to revive them.

**Influence of Ammonia on the Color of Flowers.**—Exposure to the smoke of a cigar changes violet-colored flowers to green. This change is due to the ammonia present in tobacco-smoke. The general question of the influence of ammonia on the colors of flowers has been lately investigated by Gabba, an Italian, his method being to put a little ammoniacal solution in a basin, and place a receiver over it containing the flower. In this way blue, violet, and purple flowers were changed to green, carmine-red flowers to black, white to yellow, etc. The most singular changes were presented by flowers in which several tints are combined; the red lines changed to green, the white to yellow, and so on. After the flowers have undergone these changes, if they are placed in pure water, they retain their new coloration several hours, and then gradually resume their original hues. Gabba has further observed that the flowers of aster, which are naturally inodorous, acquire an agreeable aromatic odor under the influence of ammonia. When moistened with dilute nitric acid they change from violet to red. If inclosed in a wooden case, and exposed to hydrochloric-acid vapor, they in six hours assume a beautiful carmine red.

**Metal Roofs as Lightning-Conductors.**—In a communication to the French Academy of Sciences, E. Nouel gives the results of his observations, made at Vendôme during a very violent storm. The lightning on that occasion struck some telegraph-posts and three houses. In the case of the houses, Nouel found that the lightning followed the sheet-zinc roofing (without damage) to the spouts, and thence to the earth. The author remarks that static electricity flows always to the surface of bodies, so that a gutter and its pipe, notwithstanding the thinness of the metal, constitute an excellent electric conductor, having less resistance than the best lightning-rods; that the thunder-bolt, as a rule, falls only during heavy showers, by taking advantage of the semi-communication with the earth offered by the vertical series of rain-drops. The summary of his conclusions is as follows: 1. It is possible, almost without expense, to protect ordinary houses from lightning casualties by establishing good metallic communication between the chimney-flues and roof, through the gutters, and by trusting to the rain to complete the communication to the ground. 2. That, even for complete lightning-conductors, we should utilize as a conductor the gutters and their pipings. 3. That there is need in every case to wholly replace the conductors of lightning-rods with hollow pipes of the same mass and of greater diameter. He decidedly rejects metallic cords, because electricity, always following the conductor's surface, only selects or uses from this cord a small number of its wires, which may be easily fused.

**A Botanic Garden for Chicago.**—The Commissioners of the South Park, Chicago, have in contemplation the establishment of a Botanic Garden on the following liberal plan: First, there will be a botanic garden proper, in which all indigenous plants of the United States, and hardy species from other countries, will be arranged, as far as possible, according to their natural affinities, while hot-houses and green-houses will be provided for the reception and display of tropical plants. There will also be an arboretum, or collection of hardy trees, from all parts of the world, planted in such order as to serve the purposes of science and ornament; a garden devoted to floriculture; a botanical museum, for the exhibition of vegetable economic products; an herbarium, or collection of specimens of dried plants, scientifically arranged; finally, a library of botanical works. The South Park comprises about 1,200 acres, and the commis-

sioners will reserve for the Botanic Garden all the space which may be required for present and prospective use. Prof. H. H. Babcock has been chosen as Botanical Director.

## NOTES.

A. McDougall recently exhibited to the Manchester Philosophical Society a specimen of carbon which had formed upon the roof of a gas-retort, by the decomposition of the hydrocarbon gas by heat. This carbon resembles graphite, and its mode of formation might possibly explain that of graphite. The latter mineral always occurs in association with rocks which have been subjected to igneous action, and may have been formed by hydrocarbon gases traversing fissures, the sides of which were in a highly-heated state.

The adulteration of tobacco is extensively practised in England. A cigar-maker was recently found guilty of manufacturing cigars which contained 74 per cent. of lime-leaves, 7 per cent. of colored paper, and only 19 per cent. of tobacco.

Some one in Texas is examining the annual rings on trees with reference to the effect of very dry seasons upon tree-growth. He has a theory that a series of such seasons may return in regular periodicity, the discovery of which would be of great value to the farmer, since it would enable him to anticipate short crops, and, by previous surplus ones, prepare for them. He has selected for his purpose the burr-oak, on some of which he finds a record of the growth of three hundred years. So far as he has traced back human records, he finds each very dry season marked by rings of extraordinary thinness. He is still tracing back the records of man and Nature in the hope of discovering the law above referred to.—*Department of Agriculture.*

Antimony, equal to the best English, is produced in San Francisco from native ore, and might be sold there at a far lower price than the imported article. In practice, however, the California metal has to be shipped to New York, and then returned to San Francisco as *imported* antimony, consumers persisting in the belief that, unless it comes from England, it is of little value!

A Western farmer communicates to the *American Chemist* a method of preserving wooden posts, so that they will last longer than iron in the ground, while the cost does not exceed two cents per post. This is the recipe: Take boiled linseed-oil and stir into it pulverized charcoal to the consistency of paint, and put a coat of this over the timber.

The case of the *ecstatica*, Louise Lateau, who says that for years she has partaken of no food, has been considered in the Brussels Academy of Medicine. The opinion of the Academy is: "That Louise works and requires food. When she breathes, she exhales water-vapor and carbonic acid; her weight has not decreased since she has been observed; she therefore consumes carbon which is not furnished by her system. Whoever alleges that Louise Lateau is not subject to physiological laws, must prove it; until this is done physiology will pronounce the miracle a deception."

A new mammalian genus, *Mixocebus*, is described by Peters in the *Monatsberichte* of the Berlin Academy of Science. It is most nearly allied to *Lepidolemur*, and is covered with a brown fur, except the head and neck, which are of lighter color. The tail is longer than the body. The feet are, in shape, not unlike human hands, and the thumbs of all four feet are opposable. Habitat, Madagascar.

Sir Charles Lyell bequeathed to the British Geological Society £2,000 as a fund for the promotion of geological research. The award is to be accompanied by a "Lyell Medal," and to be open to geologists without distinction of nationality or of sex.

An International Congress of "Americanists" is to assemble at Nancy, France, on the 22d of July. The object is to bring together those who are interested in the history of America prior to its discovery by Columbus, and in the interpretation of the monuments and the ethnology of the aboriginal races.

At the Philadelphia Academy of Sciences, Mr. Willard gave two instances of the brittleness of iron under the low temperature of the past winter. In breaking up an old locomotive, the cutting off of the rivet-heads, which usually requires heavy sledging, was effected by a single blow. Again, in the forging of a long steamboat shaft of the best hammered iron, which hung balanced in a crane, the hammering of the heated end caused vibration in the other end, which caused the beam to break sharp near the point of support.

There are now manufactured in England candles containing in their substance some of those gum-resins and balsams, especially benzoin and storax, which have been found useful in chronic pulmonary and allied maladies. These "pulmonic candles" yield, on combustion, a pleasing fragrance, and at the same time give a good light.

All the steamers afloat on the Caspian Sea use petroleum exclusively for fuel, burning it with the aid of a blast of steam.

CANADA rice-grass is said to afford an excellent material for the manufacture of paper. It is comparatively free from silicates, and the paper is quite as strong and flexible as that made from rags. It is easily bleached, pure in color, and presents a surface of perfect evenness. It also takes a very clear impression from the printer's types. The plant grows wild, and in great abundance, in the United States and Canada.

EXPERIMENTS made by Dr. Chassaignol, of Brest, show that the flesh of drunkards is not more inflammable after death than the flesh of those who have been abstemious; even when soaked for several days in alcohol, it burns with difficulty.

To determine the true nature of the acid principle of gastric juice, the French physiologist Rabuteau took juice from the stomach of a dog which had been allowed to fast for twenty-four hours, and then fed on bits of tendon. To the filtered liquid he added as much quinia as it would dissolve. Then it was dried *in vacuo*, and the residue treated first with amylic alcohol, then with chloroform or benzine. On evaporation, a pure hydrochlorate of quinia was obtained. No trace of lactic acid was found.

DIED, March 2d, ROBERT WILLIS, F. R. S., Professor of Natural and Experimental Philosophy in the University of Cambridge, England, for nearly forty years. Deceased had been President of the British Association, and at the time of his death was one of the Visitors of the Greenwich Observatory.

A PLEASING illustration of the deep popular interest now almost universally taken in scientific research comes to us from Sweden. Dr. Berggren, a Swedish botanist, who had explored Spitzbergen in 1868, and Greenland in 1870, found himself last year in New Zealand without the means necessary for pursuing his investigations into the flora of that country. The situation was made public by a Swedish newspaper, and immediately the proprietors of another Swedish newspaper, *Göteborg's Post*, forwarded a large sum toward the prosecution of the work, and private contributions came in so rapidly that Dr. Berggren is now in possession of all the pecuniary aid he needs.

DURING the extreme cold of the past winter, the Messrs. Becquerel made observations on the effect of the presence or absence of turf on the temperature of the soil beneath the surface. Both of the soils under observation were covered with snow. It was found that, the temperature of the air being from 0° to 12° Cent., that of the turf-covered soil, at the depth of twenty inches, was never so low as zero, whereas in the case of denuded soil the temperature was nearly 5° below zero (Cent.).

DÖRING, a German physician, asserts that an average dose of four grammes of chloral hydrate suffices not only to procure rest and sleep in case of sea-sickness, but even to entirely cure the disorder.

DR. J. D. HOOKER, President of the British Royal Society, questions the expediency of recognizing scientific services and discoveries by such trivial rewards as *medals*. He favors some other form of award which might convey to the public a more prominent and a more permanent record of the services done by the recipients.

PROF. DE BARY, of Strasburg, is inclined to believe that the *Peronospora infestans*, or parasitic fungus of the potato, passes a portion of its life upon some other plant. Probably both clover and straw are capable of entertaining the *Peronospora*. If this is the case, it gives confirmation to the prevailing opinion that barn-yard manure promotes potato-disease, especially when applied in spring. The theory can be easily tested.

A LETTER to the Department of Agriculture from San Joaquin County, California, states that hundreds of tons of the finest grapes were left on the vines in that county at the close of the past season, there being no demand for them. Wine-makers were paying only $15 per ton, and very few were buying even at that price.

IT has been asserted that oxides of nitrogen may be produced by oxidation of atmospheric nitrogen through the agency of ozone, but, from experiments made by Prof. Carius, it appears that free nitrogen remains unacted on in the presence of this active oxygen. He believes that the most important reaction in Nature by which nitrates and nitrites are generated is the oxidation of ammonia by means of ozone.

DURING the visit of Prof. W. D. Whitney to England, this spring, the British Philological Society will hold a special meeting for the purpose of hearing a paper from him. Prof. Whitney has just finished a volume for the "International Scientific Series" on the "Life and Growth of Language."

AN English sanitarian, Dr. Yeld, of Sunderland, contends for the superiority of seawater over fresh water in street sprinkling, and alleges that when treated by the former the streets remain much longer moist even during very hot weather, and that by its means the cohesive power of the materials of a road is increased.

DYNAMITE is employed in France for the purpose of breaking up old cannon. The proportion of dynamite required for this purpose is only about one-thousandth part of the weight of the iron.

WILLIAM ROBERT GROVE.